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SECOND EDITION

Complete Book of Framing

An Illustrated Guide for Residential Construction

Scot Simpson

Complete Book of FRAMING

An Illustrated Guide for Residential Construction

Second Edition

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John Wiley & Sons, Inc.

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TABLE OF CONTENTS

About the Author	xi
Acknowledgments	xiii
Introduction	xv
Chapter 1: Introduction to Framing	1
Framing Terms	4
Framing Lumber	6
Framing Sheathing	7
Engineered Wood Products	8
Lumber & Wood Structural Panel Grade Stamps	12
Framing Nails	13
Framing Tools	14
Framing Tool Truck	16
Cutting Lumber	17
Protecting Lumber from Decay	18
Preservative Treated Wood	20
Chapter 2: Nailing Patterns	21
Nail Top Plate to Studs	24
Nail Bottom Plate to Studs	24
Nail Double Plate to Top Plate	25
Nail Corner	25
Nail Walls Together or Nail Double Studs	25
Nail Trimmer to Stud	26

Concrete Nailing 26
Nail Bearing & Nonbearing Walls to Floor Perpendicular to Joists 27
Nail Bearing & Nonbearing Walls to Floor Parallel to Joists 27
Nail Header to Stud 28
Nail Let-in Bracing 29
Nail End of Joist 30
Nail Rim Joist 30
Nail Sheathing 31
Nail Built-up Girders & Beams 32
Nail Joist Blocking 32
Nail Lapping Joists 33
Nail Drywall Backing 33
Nail Trusses to Wall 34
Nail Ceiling Joist, Rafters, & Ridge 34
Nail Rafters to Wall 35
Nail Blocks 35
Nail Fascia & Bargeboard 36
Chapter 3: Floor Framing 37
Step 1–Crown & Place Joists 40
Steps 2 & 3–Nail Rim Joists in Place & Cut Joists to Length 41
Step 4–Nail Joists in Place 42
Step 5–Frame Openings in Joists 43
Steps 6 & 7–Block Bearing Walls & Nail Joists to Walls 44
Step 8–Drywall Backing 45
Step 9–Subfloor Sheathing 46
Chapter 4: Wall Framing 47
Step 1–Spread Headers 50
Step 2–Spread Makeup 51
Steps 3–7–Assemble Wall 52
Step 8–Square Wall 53
Step 9–Sheathe Wall 54
Step 10–Install Nail-Flange Windows 55

Steps 11–15–Standing & Setting Wall 56
Step 16–Plumb & Line 57
Framing Rake Walls 60

Chapter 5: Roof Framing 69
Roof Framing Terms 72
Step 1–Find the Lengths of Common Rafters 74
Step 2–Cut Common Rafter 83
Step 3–Set Ridge Board 86
Step 4–Set Common Rafters 87
Step 5–Find Length of Hip & Valley Rafters 88
Step 6–Cut Hip & Valley Rafters 89
Step 7–Set Hip & Valley Rafters 91
Step 8–Set Jack Rafters 92
Step 9–Block Rafters & Lookouts 93
Step 10–Set Fascia 93
Step 11–Install Sheathing 94
Rafter Guidelines 95
Ceiling Joists 106
Step 1–Spread Trusses 108
Step 2–Sheathe Gable Ends 109
Step 3–Set Gable Ends 109
Step 4–Roll Trusses 110
Steps 5–8 111

Chapter 6: Doors, Windows, & Stairs 113
Door Framing Terms 116
Installation of Exterior Doors 116
Installation of Nail-Flange Window 119
Installation of Window Flashing 120
Installation of Sliding Glass Doors 121
Installation of Stairs 122
Circular Stairs 127

Chapter 7: Layout 135
Wall Layout 139
Joist Layout 154

Rafter or Truss Layout 156
Roof Layout 156

Chapter 8: Engineered Wood Products 159
Engineered Panel Products 162
Engineered Lumber Products 163

Chapter 9: Wind & Earthquake Framing 183
The Strength of Good Framing 186
Understanding Structural Loads 186
Building Code Load Requirements 187
Regional Considerations 188
Framing Details 188
Hold-Downs 195
Positive Placement Nail Guns 200

Chapter 10: Building Code Requirements 203
Introduction to Building Codes 206
Framing According to Code 210
Protection from Decay 228
Termite Protection 234

Chapter 11: Green Framing 235
Green Framing Feeling 238
Advanced Framing 238
Material Selection 240
Structural Insulated Panels (SIPs) 241
SIP Installation 241
SIP Tools 247

Chapter 12: Preparing for a Job 249
Developing a Job Start Checklist 252
Reviewing the Plans & Making Preparations 255
Organizing the Job Site 259

Chapter 13: Managing the Framing Start 263
Checking Exterior Wall Dimensions 266
Checking Reference Lines for Square 267
Adjusting Reference Lines 268
Checking the Building for Level 270

Chapter 14: Managing a Framing Team 275
Managing Your Team 278
The Role of Lead Framers 279
Quality Control 288
Organizing Tools & Materials 289
Teaching Framers 292
Framing Tips for Every Task 294
Planning & Scheduling 302
Recordkeeping 304
Productivity 306
Chapter 15: Safety 311
Personal Protective Equipment 314
Hand Tools 315
Ladders 317
Fall Protection 317
Rough Terrain Forklift Safety 319
Housekeeping 321
Glossary 325
Spanish Framing Terms 335
Index 343

ABOUT THE AUTHOR

Scot Simpson has been framing houses, schools, and commercial buildings for 39-years—and has owned a construction firm for 34-years. His firm, S.S. Framing, Inc., is based in Edmonds, WA. He developed and refined the methods in this book and uses them to train his crews. Scot is the author of two other construction books and many articles for construction magazines, such as *Fine Homebuilding* and the *Journal of Light Construction*. He developed and hosted the video, "Resisting the Forces of Earthquakes" with the Earthquake Engineering Research Institute and the International Conference of Building Officials.

Scot is a member of the International Code Council (ICC), the Construction Specifications Institute (CSI), the Associated General Contractors of America (AGC), and was 2006 Chairman of the ABC Framers Council. He has presented training and seminars for the National Association of Homebuilders, the American Forest and Paper Association, and the International Conference of Building Officials, among others, both in the U.S. and internationally.

Scot holds an MBA from Kent State University, as well as a BA and technical certificates in carpentry instruction, lumber grading, and industrial first aid.

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Bruce Simpson; Mars Simpson; Casey Miller; Paul Nelson; Allan R. Simpson, Jr.; John E. Farrier; APA, the Engineered Wood Association; The Association of Mechanical Engineers (ASME); Digital Canal Corporation; iLevel, a Weyerhaeuser Business, Boise, Idaho; The International Code Council (ICC); The Mason Contractors Association of America (MCAA); Sampson Lumber Company; The Simpson Strong-Tie Company; The Truss Plate Institute; the U.S. Geological Survey National Seismic Hazard Mapping Project; the Western Wood Products Association (WWPA); and Premier Building Systems.

INTRODUCTION

I'm a framing contractor. I've spent most of my career as a lead framer, directing my framing crews and training workers to become framers. In my teaching, I found that much of the information I needed was not available in a good book, so I wrote one, *Framing & Rough Carpentry.* As I started spending more of my time training and working with lead framers, I again looked for a good, easy-to-understand reference. I didn't find what I needed, so I wrote another book, *Advanced Framing Methods*, that provides all the information a framer needs to move up to the next level—becoming a lead framer. *The Complete Book of Framing* is the combination of those two books, updated with full-color illustrations and photographs, plus additional information—all presented in what I've come to think of as a "framer-friendly" format.

If you're a novice with no framing experience, you'll see the basics of framing shown in a simple, step-by-step style that makes it easy to learn. Where possible, I included both photographs and drawings for each step—for quick and complete learning. The advanced information will be more difficult for a novice to understand, but getting a good feel for the framing basics that come before it will help. The more advanced tasks are also explained with photos and clear drawings.

If you're already an experienced framer, the book gives you some unique tools that you won't find anywhere else. For example, after struggling with rafters and rake walls for years, I developed a diagonal percent system that makes it easier. I use this for finding rafter lengths and rake wall stud heights. The book also explains all the "classic" methods for doing these tasks, but once you try the diagonal percent system, I doubt you'll go back to the old methods. Another example of the book's unique style of presentation is the layout language, which I developed for my first book.

If you're a lead framer, all the basic framing steps presented are important for reference and to help you teach and train crews. Most valuable, however, will be the guidance on managing a framing crew. Once you become a lead framer, your productivity is defined by the productivity of your crew. You'll need to think about the information they need and how to teach and manage them most effectively. Chapter 14 of this book is like a mini framer management course.

The charts and graphs in the book present information that is needed to manage a framing crew, but is not readily available. For example, the *International Building Code* chart makes it easy to reference the latest information governing framing. The Standard Framing Dimensions chart gathers the information that you "sort-of" remember, but it helps to have it handy for quick reference.

This book covers all the major topics related to framing. Each is presented in the easiest learning method. Because the framing tasks are diverse and vary in complexity, the format also varies a little throughout the book. All of the topics are covered in a framer-friendly way.

Framing is very rewarding work, both physically and mentally. One of the biggest challenges, however, is getting accurate information every time so that you can be sure you're framing a structure correctly. This book will assist you in that task.

Happy Framing,
Scot

Chapter One

INTRODUCTION TO FRAMING

Contents

Framing Terms	4
Framing Lumber	6
Framing Sheathing	7
Engineered Wood Products	8
Lumber & Wood Structural Panel Grade Stamps	12
Framing Nails	13
Framing Tools	14
Framing Tool Truck	16
Cutting Lumber	17
Protecting Lumber from Decay	18
Preservative Treated Wood	20

Chapter One

INTRODUCTION TO FRAMING

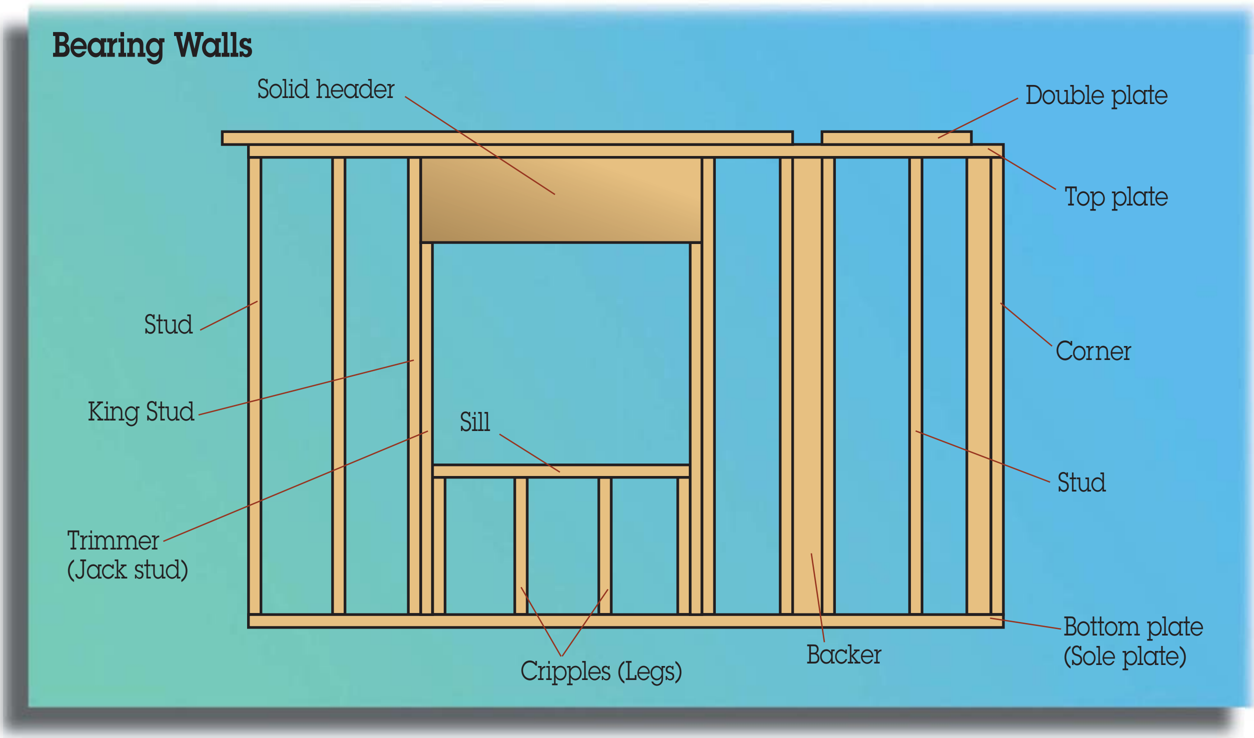
The trade of wood framing comprises the rough carpentry skills needed to produce the "skeleton" of a building and its first layer of "skin." The skeleton consists of the structural lumber forming the floors, walls, and roof. The skin consists of the lumber that encloses the skeleton and provides a surface for subsequent layers of protective and decorative finish materials.

This chapter is an illustrated review of a framer's most basic tools, materials, and terminology. This basic information is often not even taught on the job site, so if you don't know it when you arrive for work, you will have to play a guessing game or ask a lot of questions.

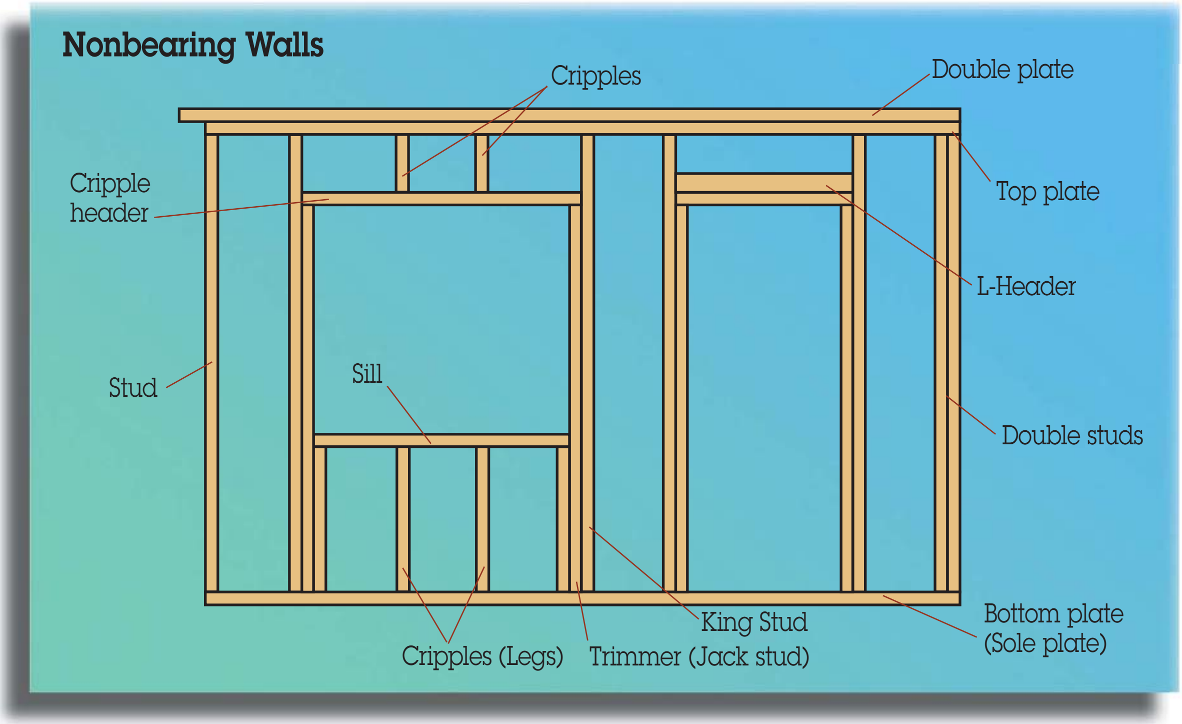
The detailed illustrations serve as a handy reference and help to reduce confusion when different words are used for the same item. Confusion can arise when framers move from job site to job site and work with different people. For example, bottom plates are often known as *sole plates*, backers as *partitions*, and trimmers as *jack studs*. But it doesn't matter what they are called as long as you know what they are. There is also a more detailed list of framing terms with definitions at the back of the book.

The suggested organization for a framing tool truck presented in this chapter is just an example of how a truck might be set up for tool storage. Its purpose is, once again, to reduce confusion and make the job easier. It is amazing how much time can be spent looking for tools and nails if they aren't put where you expect them to be.

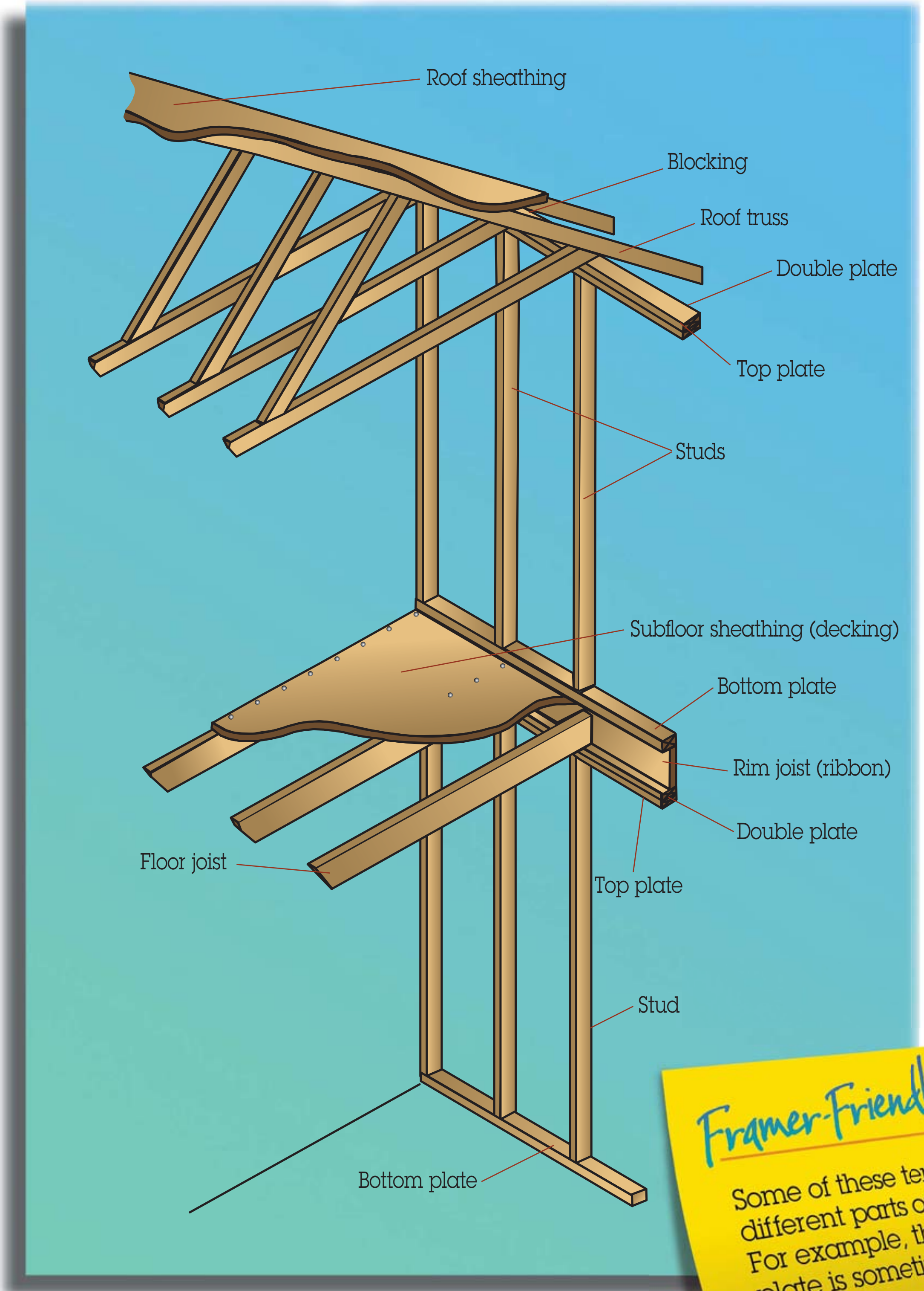
Framing Terms



Bearing walls support the main weight of an upper portion of a building, such as a ceiling, floor, or roof. Nonbearing walls provide little or no support to those upper portions. Remove nonbearing walls, and the upper portions will stand; remove bearing walls, and the upper portions will fall.



Framing Terms *(continued)*

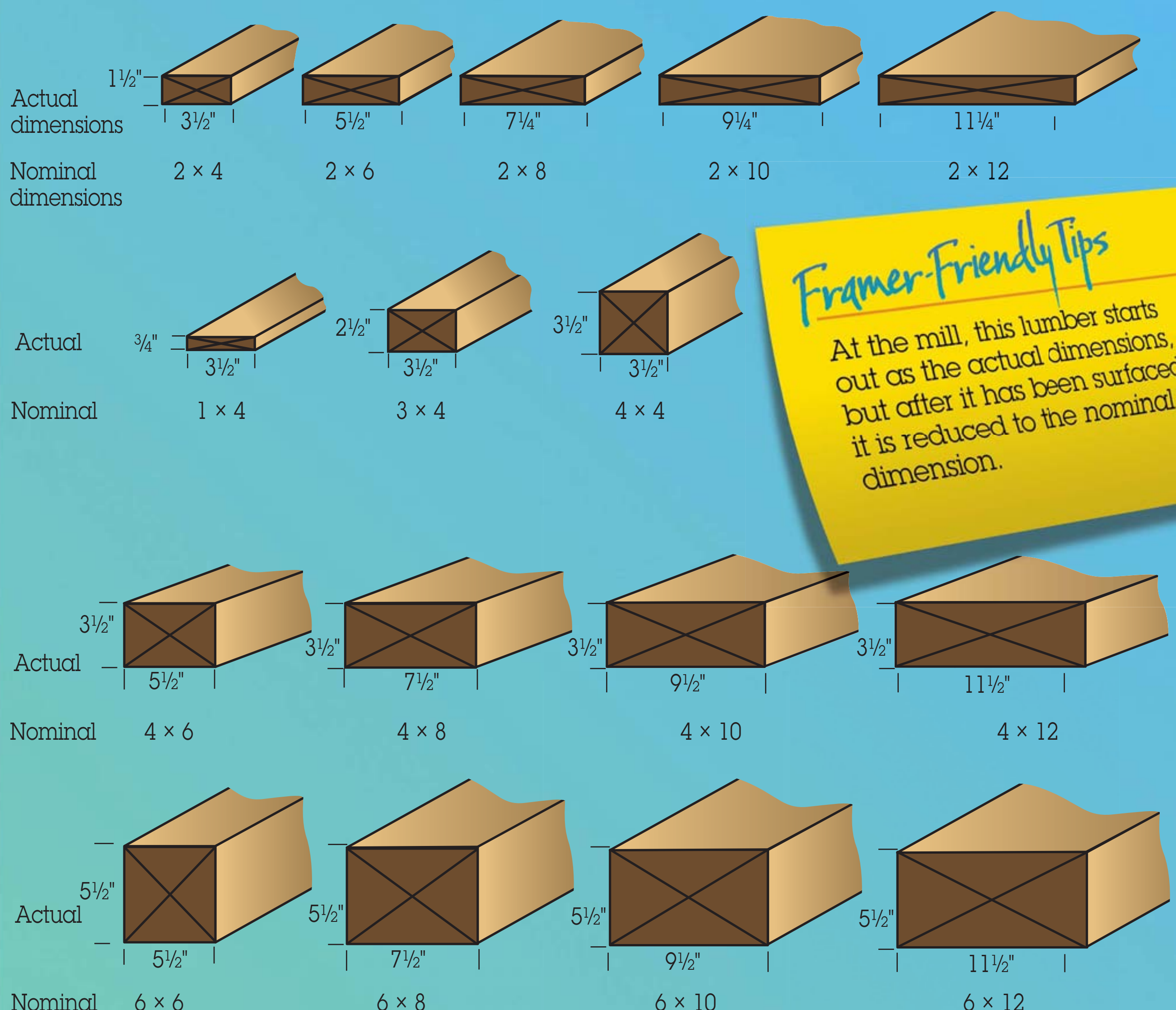


Framer-Friendly Tips

Some of these terms vary in different parts of the country. For example, the bottom plate is sometimes called the sole plate.

Framing Lumber

Lumber is sized in “nominal,” as opposed to “actual,” dimensions. A nominal dimension rounds off the actual dimension to the next highest whole number. For example, a piece of lumber that actually measures 1½"× 3½" is rounded off to the nominal 2" × 4".



Framer-Friendly Tips

At the mill, this lumber starts out as the actual dimensions, but after it has been surfaced, it is reduced to the nominal dimension.

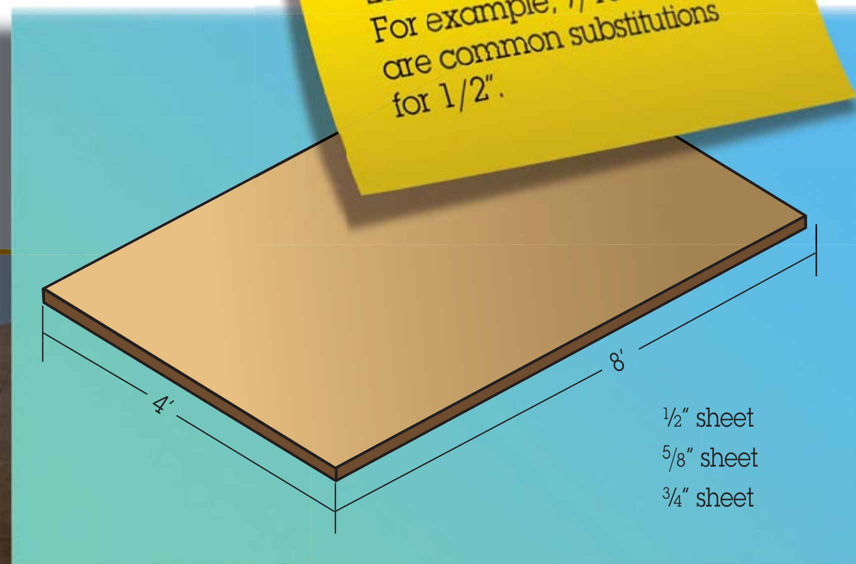
Framing Sheathing

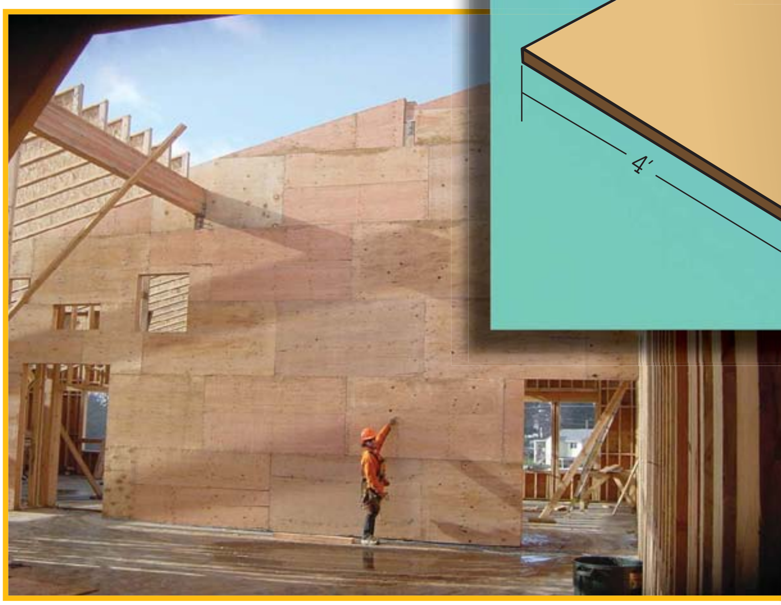
Engineered Panel Products

Sheathing comes in 4' × 8' sheets. The thicknesses most commonly used in framing are ½", ⅝", and ¾".

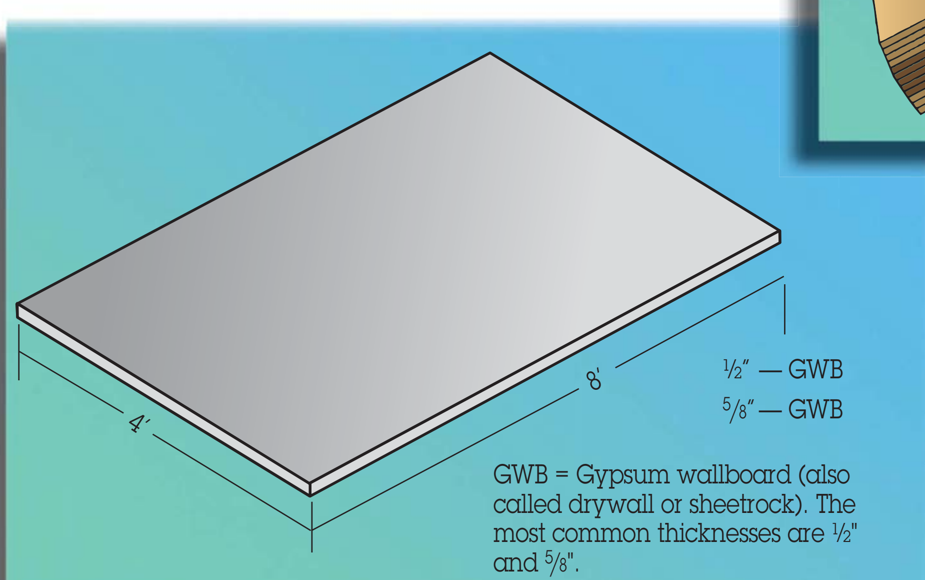
Framer-Friendly Tips

There are substitutions for these standard sizes. For example, 7/16" & 15/32" are common substitutions for 1/2".





The engineered panel products on this wall provide the strength needed for the high ceiling of this elementary school.



Although not as common in house framing, gypsum wallboard can be used on exterior walls, such as for apartments and condos, and commercial buildings for fire protection.

Dens Glass® gypsum sheathing is a brand that has fiberglass mat, which provides mold and moisture resistance and is gold in color.

Engineered Wood Products

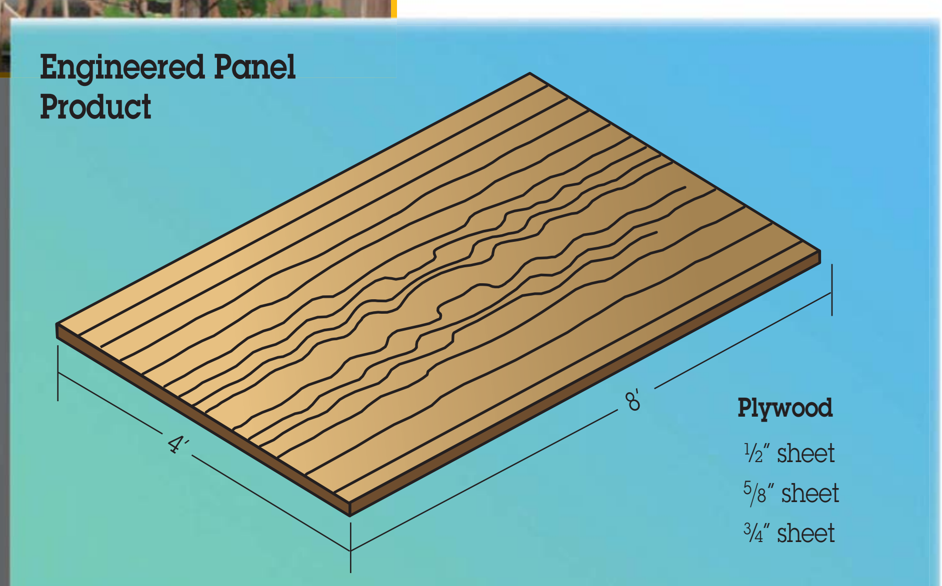
Engineered wood products are becoming more and more a part of our everyday framing. The strengths of these different products vary. Whenever you use engineered wood, it is important that you understand the qualities of the specific product you are planning to use, as well as structural considerations and any restrictions on cutting and installation.

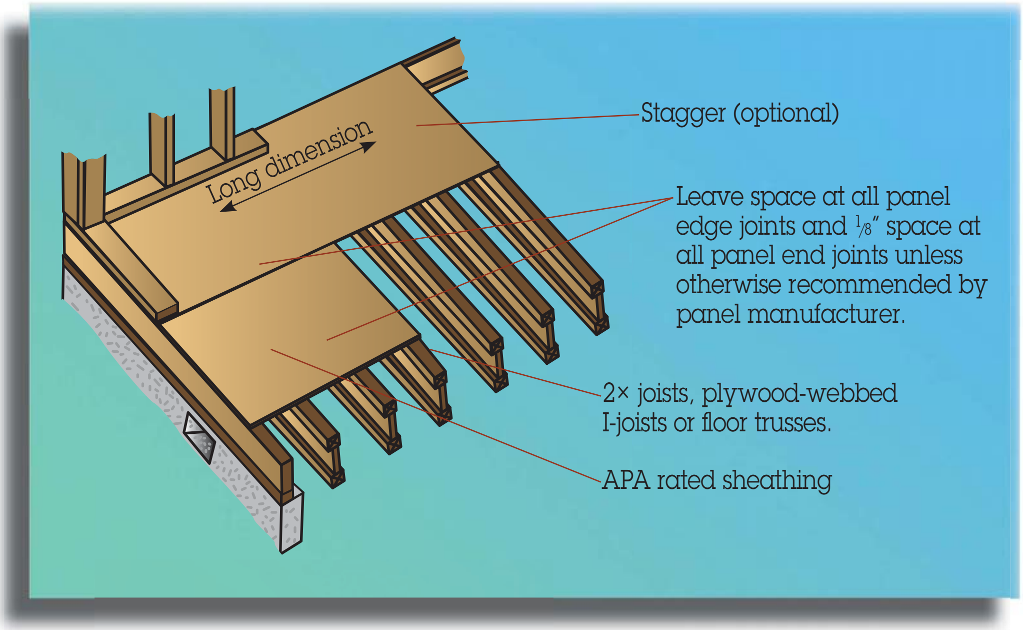
Engineered wood products can be divided into two categories: **engineered panel products** and **engineered lumber products**. Engineered panel products include plywood, oriented strand board (OSB), waferboard, composite, and structural particleboard. Engineered lumber products include I-joists, glu-lam beams, LVLs (laminated veneer lumber), PSLs (parallel strand lumber), and LSLs (laminated strand lumber).

Engineered wood products have structural qualities different than those of traditional wood, so they must be used within the specification set by the manufacturer. When these products are specified on the plans, the architect or engineer who specified them will have checked with the structural engineer to ensure proper use.

Engineered panel products have been around for years and are treated in a

I-joists are engineered panel products that provide consistency and fewer floor squeaks.





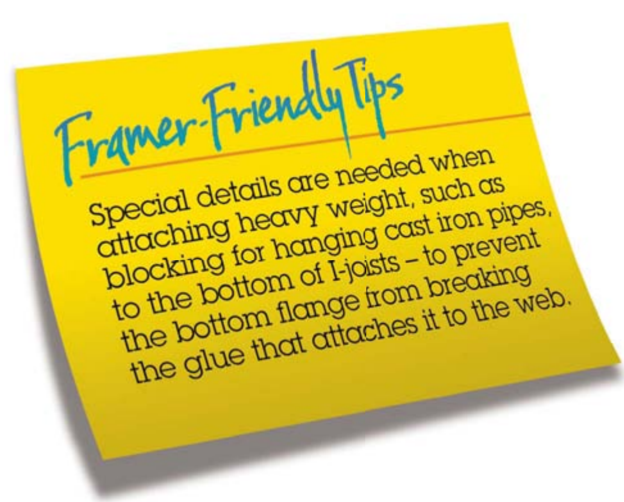
manner similar to engineered wood products. The 4' × 8' typical sheets are strongest in the direction of the grain. For floors and roofs, these sheets should be laid perpendicular to the direction of the supporting members. The strength of the panels comes from the panel cantilevering over the supports—so each piece should be at least as long as two support members.

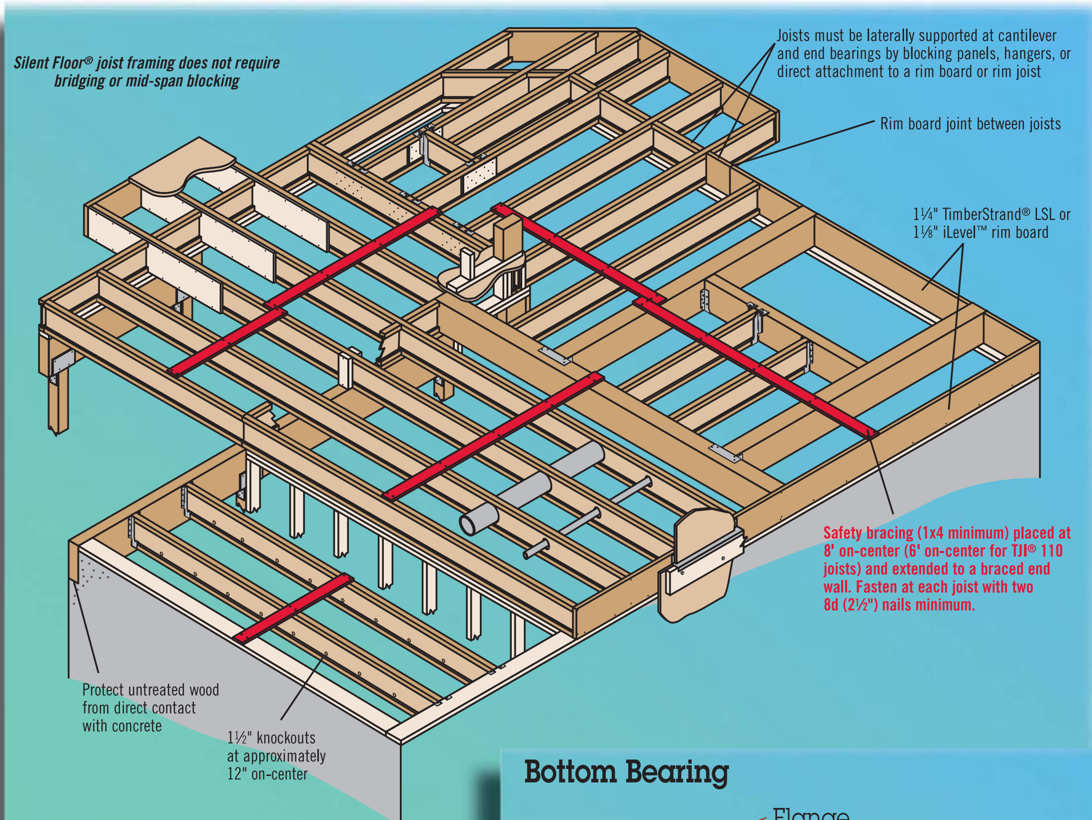
Glu-lam beams, LVLs, PSLs, and LSLs can be cut to length, but should not be drilled or notched without checking with manufacturers' specifications.

I-joists are becoming more widely used. Although the Engineered Wood Association has a standard for I-joists, not all I-joists manufacturers subscribe to that standard. Consequently, it is important to follow the manufacturer's instructions whenever using I-joists. Installation instructions are usually delivered with the load for each job. The illustration shows some of the typical instructions.

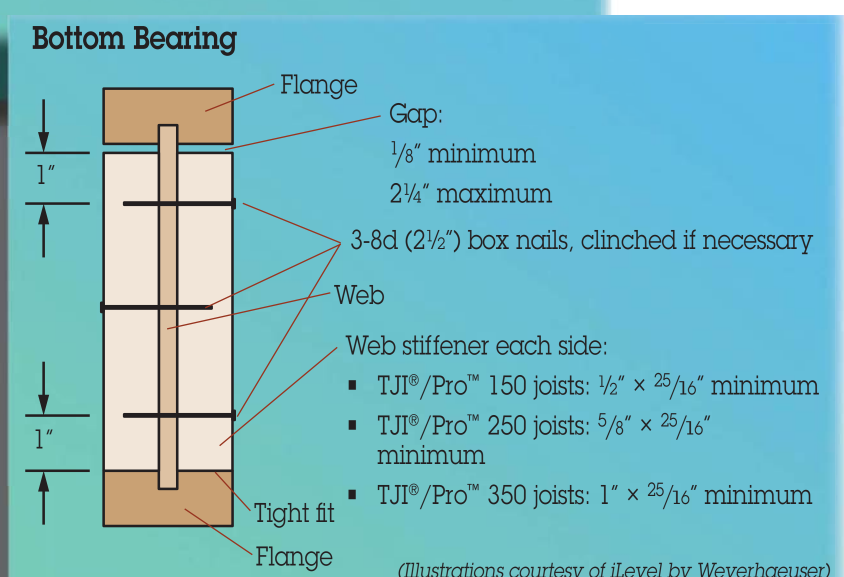
Certain features are common among all I-joists. Rim and blocking may be of I-joist or solid rim board. Typical widths are 9½", 11 7/8", 14", 16", and 20".

Web stiffeners are used to add to the strength at bearing points. If the bearing point is at the bottom flange, then the web stiffener, which is the thickness of the flange on one side of the web, is held tight to the bottom. There should be at least a 1/8" space between the top flange and the web stiffener. If the bearing point is at the top flange, then the web stiffener is held tight to the top with at least 1/8" between the bottom flange and the web stiffener.





Common construction details for engineered lumber joists.



Section view of I-joist. Please note the components of the joist (darker colors) and the web stiffener (lighter color). Fasteners are shown in black.

Framer-Friendly Tips

Nails that stick through both web stiffeners need to be clinched (bent over).

Engineered Wood Products *(continued)*

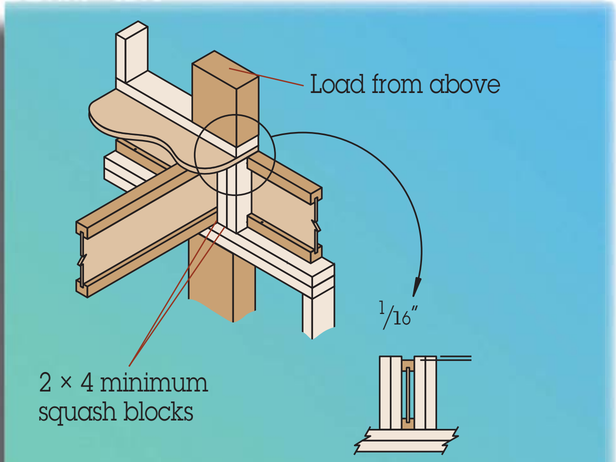
Squash blocks are pieces of lumber installed alongside TJI's at points of heavy loading. They prevent the weight from crushing the TJI. They are typically dimensional lumber like 2 × 4s or 2 × 6s. They should be cut 1/16" longer than the I-joist to take the load off the I-joists.

I-joist hardware, such as hangers, is usually delivered with the I-joist package. However, standard I-joist hardware can be purchased separately.

I-joists typically require a 1¾" bearing. You can cut the end of an I-joist as long as it is not cut beyond a line straight up from the end of the bearing. However, no cuts should extend beyond a vertical line drawn from the end of the bearing point.

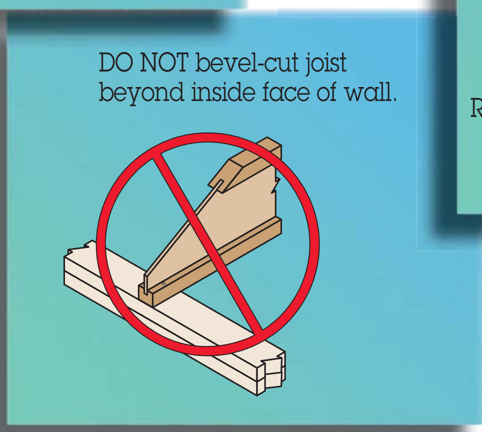
Framer-Friendly Tips

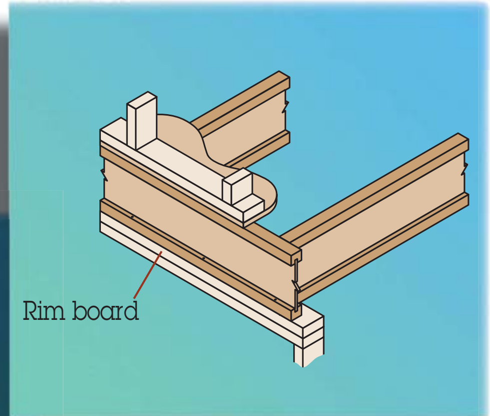
Check the floor above for posts, columns, or concentrated loads so you can install squash blocks while you are joisting.



(Illustrations courtesy of iLevel by Weyerhaeuser)

Squash blocks should be 1/16" greater than the I-joist height.



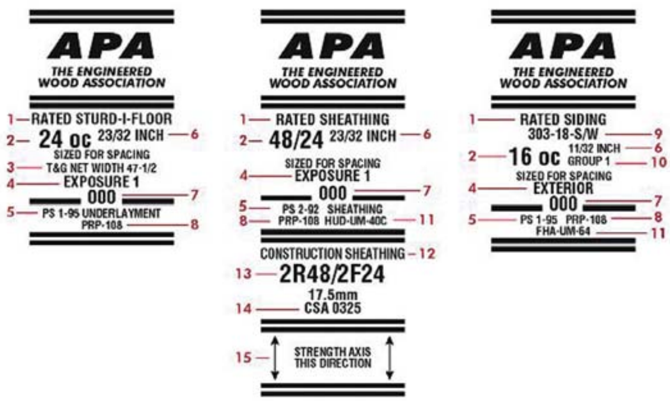


Lumber & Wood Structural Panel Grade Stamps

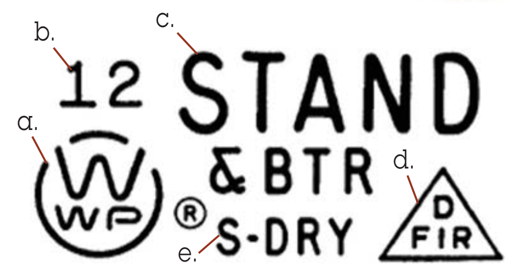
Lumber and wood structural panels are graded for strength and different uses. Each piece of lumber is stamped for identification before it is shipped.

Architects specify grades of lumber and wood structural panels for various purposes, and framers need to make sure the right wood is used.

Wood Structural Panels



1. Panel grade
2. Span rating
3. Tongue-and-groove
4. Exposure durability classification
5. Product Standard
6. Thickness
7. Mill number
8. APA's performance rated panel standard
9. Siding face grade
10. Species group number
11. HUD/FHA recognition
12. Panel grade, Canadian standard
13. Panel mark – Rating and end-use designation,
14. Canadian standard
15. Canadian performance rated panel standard
16. Panel face orientation indicator



a. **WWPA certification mark** certifies Association Quality standards and is a registered trademark.

b. **Mill identification** Firm name, brand, or assigned mill number. WWPA can be contacted to identify an individual mill whenever necessary.

c. **Grade designation** Grade name, number, or abbreviation.

d. **Species identification** Indicates species by individual species or species combination.

e. **Condition of seasoning** Indicates condition of seasoning at time of surfacing:

MC-15 – KD-15: 15% maximum moisture content

S-DRY – KD: 19% maximum moisture content

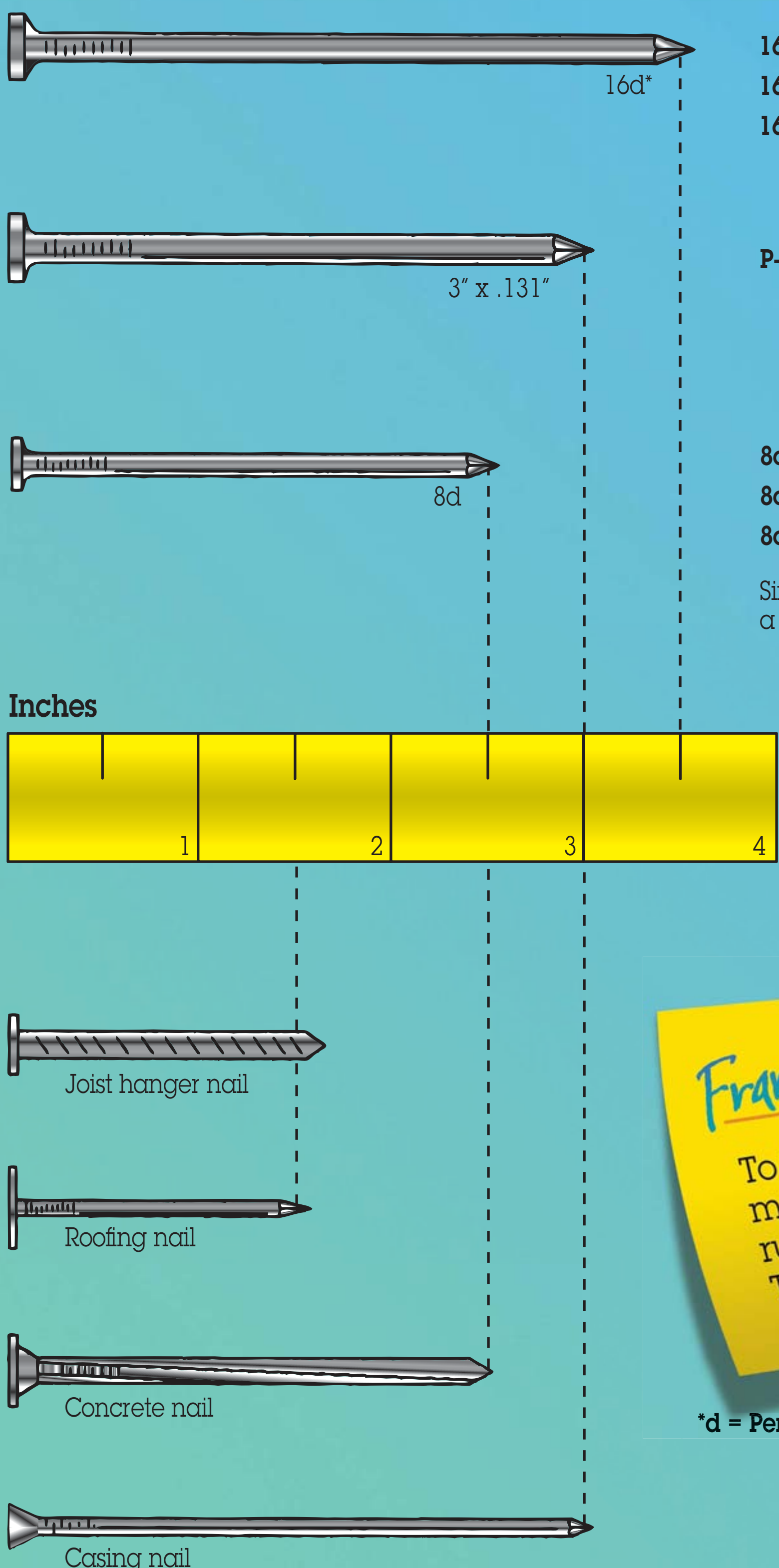
S-GRN: over 19% moisture content (unseasoned)

Lumber

Framing	Grade	Use
Light framing 2 × 2 thru 4 × 4	Construction Standard & better Utility	Plates Sills Studs over 10′
Stud 2 × 2 thru 4 × 6 10′ or less	Stud	Studs Cripples
Structural framing	Select structural No. 1 No. 2 No. 3	Joists Rafters Headers Posts Beams

Images of grade stamps courtesy of APA, The Engineered Wood Association and WWPA, the Western Wood Products Assocoiation

Framing Nails



16d Common – 3-½" long & .162" thick
16d Box – 3-½" long & .135" thick
16d Sinkers – 3-¼" long & .148" thick

P-Nail – used in a pneumatic nail gun

8d Common – 2-½" long & .131" thick
8d Box – 2-½" long & .113" thick
8d Sinkers – 2-3/8" long & .113" thick

Sinkers have a countersunk checked head and a cement or vinyl coating for easy nailing

Framer-Friendly Tips

If you're concerned about the wood splitting from the nail, tap the nail point with your hammer to dull it.

Framer-Friendly Tips

To help a nail penetrate more easily, some framers run it through their hair first. The oil acts as a lubricant.

***d = Penny**. The abbreviation comes from the Roman word "denarius," meaning coin, which the English adapted to penny. It originally referred to the cost of a specific nail per 100. Today it refers only to nail size.

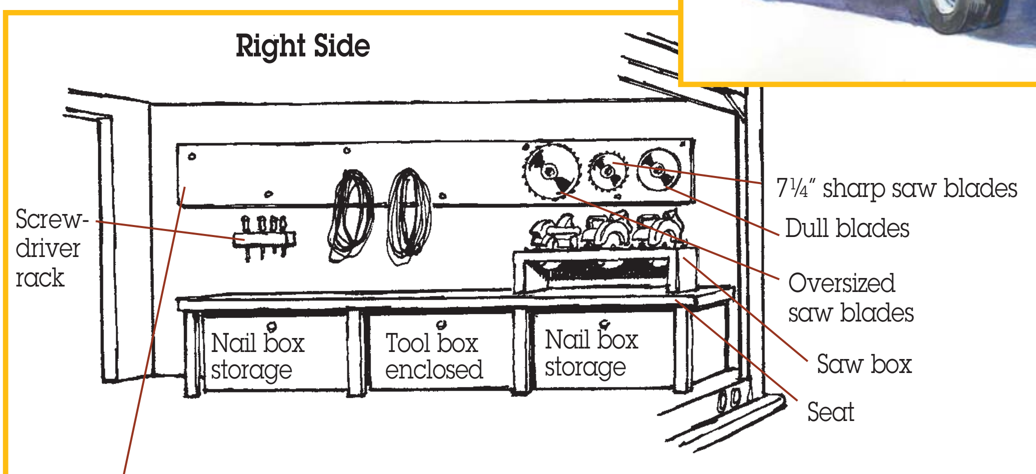
Framing Tools

Framing Tools *(continued)*

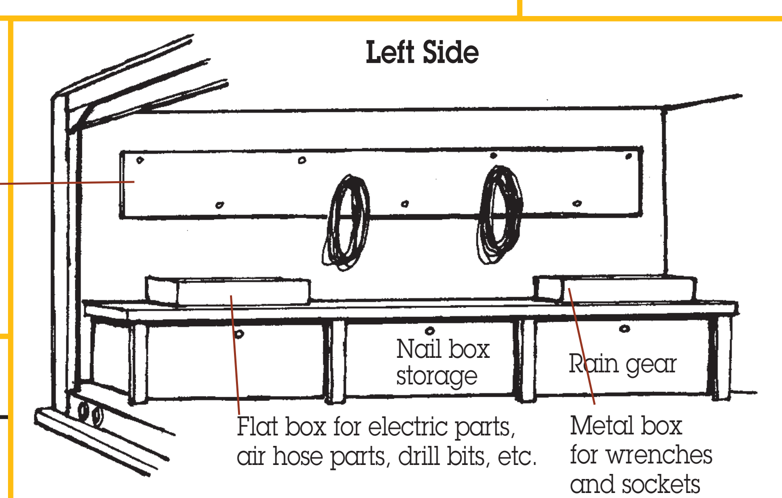
Framing Tool Truck

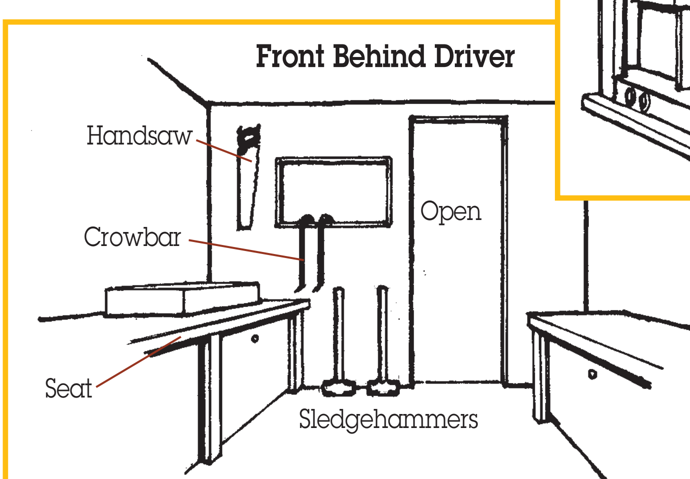
Typical Layout for a 14' Step Van

If you're a professional framer, organizing your tools helps keep them in good condition and helps you find them when you need them—saving valuable time on the job.

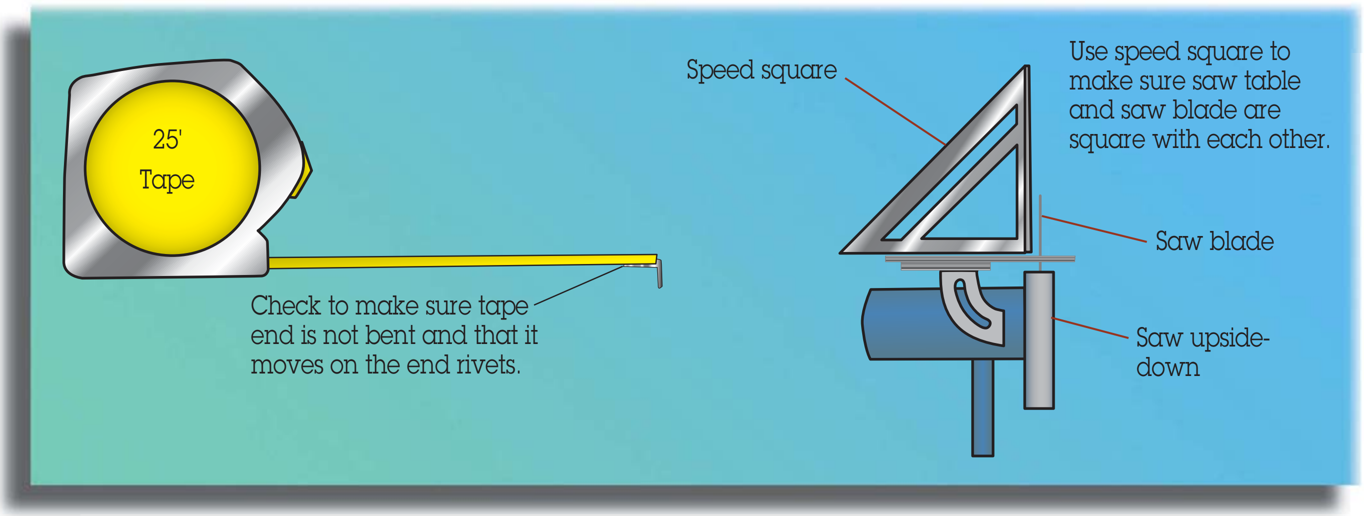


Anchor bolts attached to 2 x 10 and used for hanging air hoses, electric cords, and tool pouches





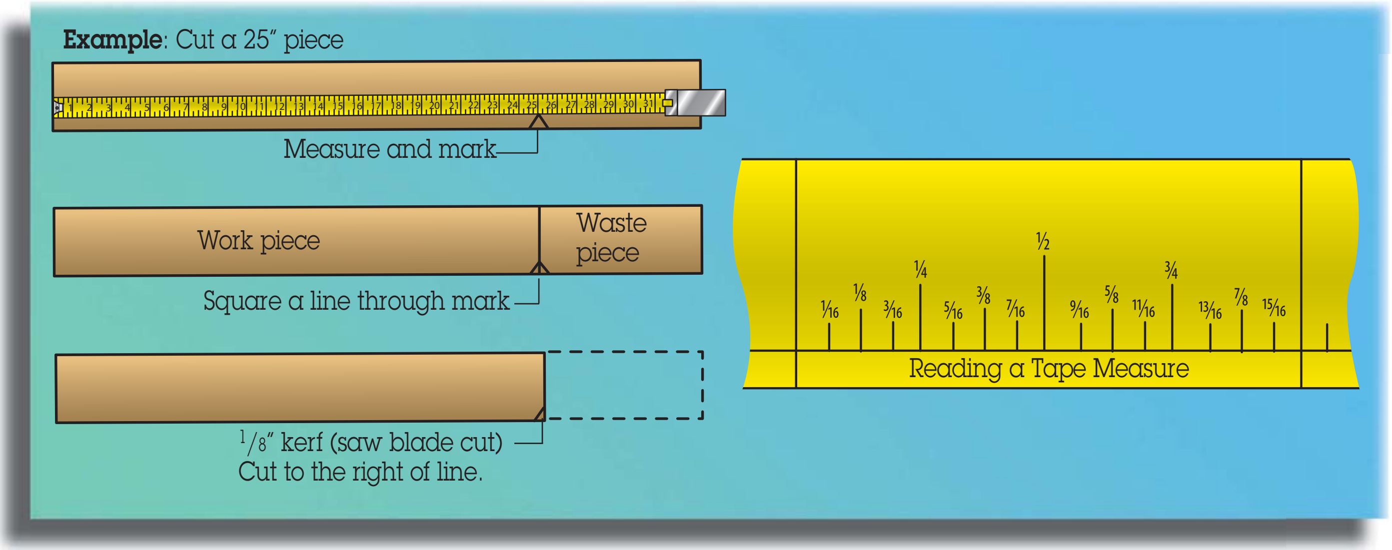
Cutting Lumber



Accuracy in measuring, marking, and cutting lumber is a very important framing skill to master. Periodic checks should be made of the condition of tape measures and the squareness of saw tables and blades.

A typical saw blade removes a channel of wood approximately 1/8" wide, called a *kerf*. This must be taken into consideration when you make a cut.

Suppose you want to cut a board 25" long. Measure and make a mark at 25", then square a line through the mark with a square. The *work piece*— the 25" piece you want to use—will be to the left of the line; the *waste piece* will be to the right. Guide your saw along the right edge of the line so the kerf is made in the waste piece. If your cut is perfectly made, the work piece will be left showing exactly half the width of your pencil line, and will measure exactly 25". Thus, the old carpenter's saying: "Leave the line."



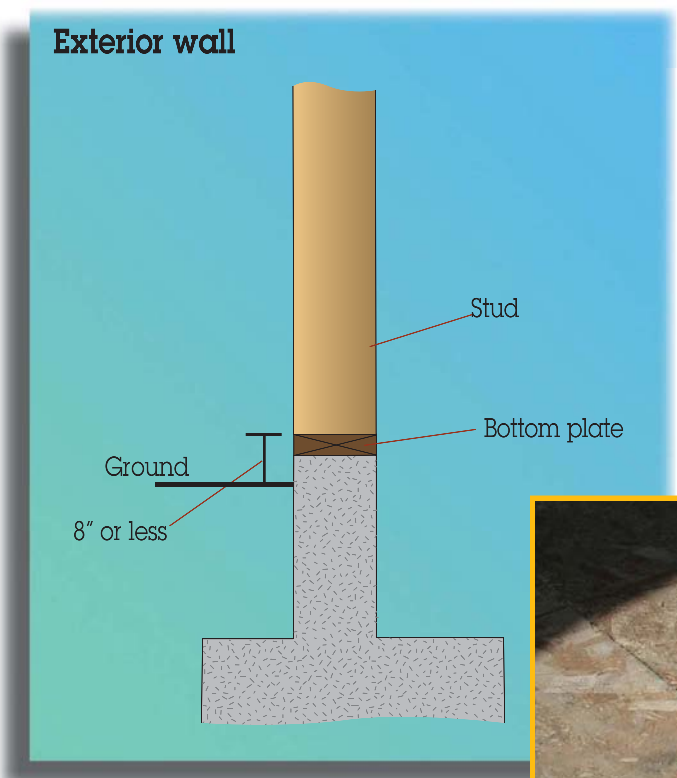
Protecting Lumber from Decay

Moisture and warmth will promote decay of most woods. To prevent decay, naturally durable woods or preservative-treated wood must be used when the wood is exposed to moisture.

Decay-resistant woods include redwood, cedar, black locust, and black walnut. Preservative-treated wood is treated according to certain industrial specifications. Preservative-treated wood is most commonly used because of its availability.

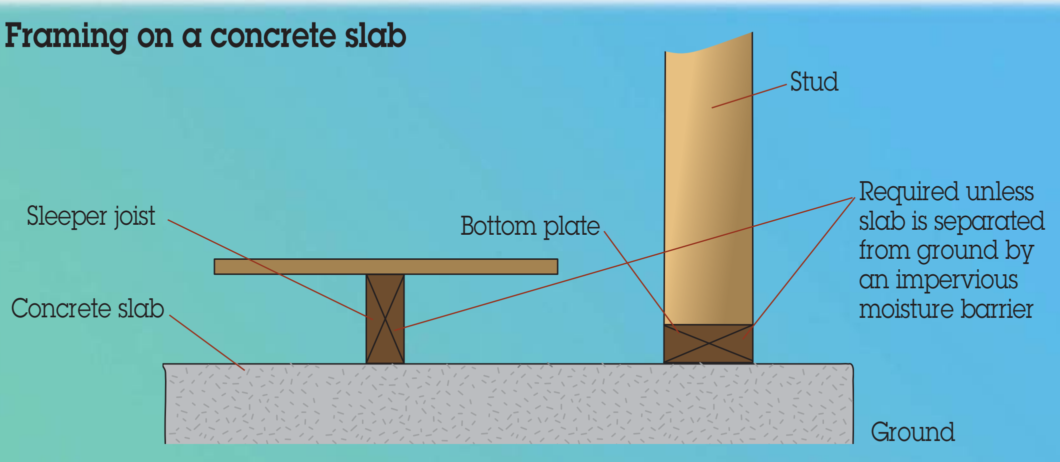
Preservative-treated or naturally durable woods should be used in the following locations:

1. On concrete foundation walls that are less than 8" from exposed earth.
2. On concrete or masonry slabs that are in direct contact with earth.
3. Where wood is attached directly to the interior of exterior masonry or concrete walls below grade.
4. For floor joists if they are closer than 18" to the exposed ground.
5. For floor girders if they are closer than 12" to the exposed ground.

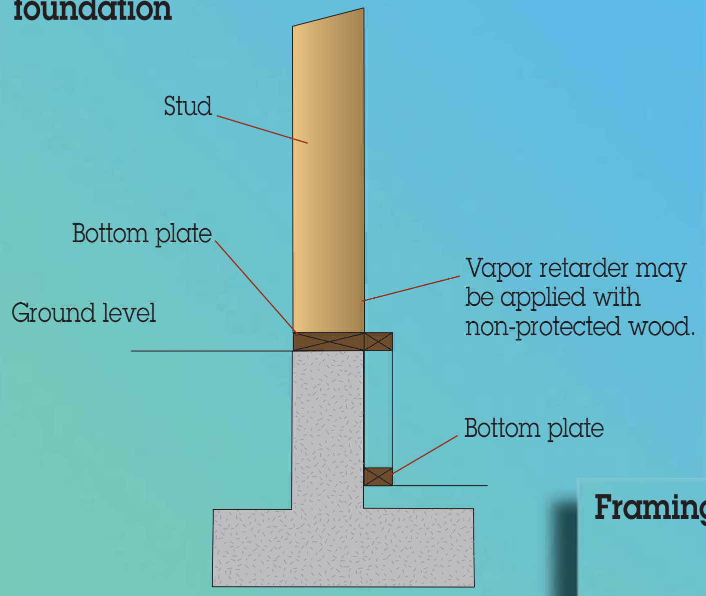


When pressure treated lumber is cut on the job site, apply treatment to the end by soaking or brushing

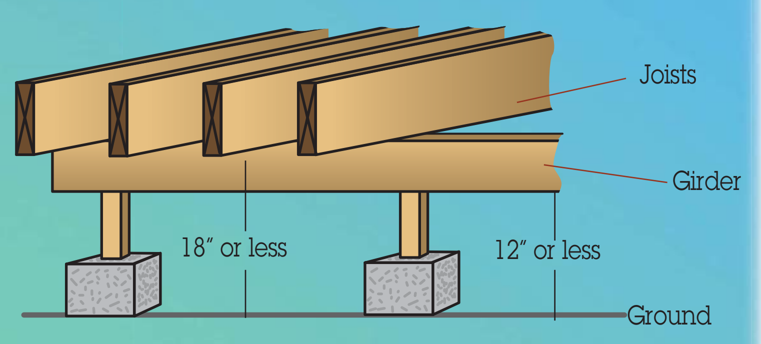
Framing on a concrete slab



Framing furring wall on a concrete foundation



Framing crawl space from ground



Preservative Treated Wood

The treating of wood in recent years has gone through some major changes. The most important thing to know is that there are different types of preservative treatment and that some of the treatments require specially coated fasteners to prevent corrosion.

A little history will help in understanding. For years the predominate chemical for preserving dimension lumber had been chromated copper arsenate (CCA). However, health concerns arose because of the arsenic content in CCA, and in 2004 the Environmental Protection Agency (EPA) required labels on CCA, which had the effect of disallowing the use of CCA-treated wood for most residential uses.

The first commonly used substitutes were copper azole (CA) and alkaline copper quaternary (ACQ). These eliminated the arsenic but created a different problem because they were corrosive to steel fasteners. To solve this problem, hardware manufacturers began making their common fasteners with a galvanized coating. For example, if you see a Simpson Strong-Tie hardware labeled Z-max you know it has been coated so that it can be used with CA and ACQ. Steel nails also had to be coated when used with lumber treated with CA or ACQ. Typically they are galvanized. Stainless steel is a better substitute for hardware and nails because it is less corrosive, but it is expensive.

Sodium Borate (SBX) preservative treatment is another substitute for CCA that does not have the problem of causing corrosion of steel fasteners, however it will wash out of the lumber with liquid exposure. It is specified for use above ground and continuously protected from liquid water.

New products are continually being developed. Carbon based compounds are among these and could prove to be less corrosive and natural in color.

The 2009 IBC & IRC code states that preservative treated wood should be in accordance with AWPA U1 (American Wood Protection Association Use Category System) for the species, product, preservative, and end use. The lumber tag attached to the treated wood will give the use category to assist you in making sure you are using the correctly treated wood.

All the different labels and chemicals can be confusing. Most importantly, make sure that you are using the right treatment for the task at hand and that you are using corrosive resistant fasteners where necessary. To check the correct use of treated lumber, read the tag attached to the lumber or ask the lumber supplier. For CA or ACQ treatment, you will need corrosion-resistant fasteners; for SBX or other borate treatments, you will not need corrosion-resistant fasteners. Beyond that, check on the fastener boxes for specifications or ask the lumber or fastener supplier.

Chapter Two
NAILING PATTERNS

Contents

Nail Top Plate to Studs 24
Nail Bottom Plate to Studs 24
Nail Double Plate to Top Plate 25
Nail Corner 25
Nail Walls Together or Nail Double Studs 25
Nail Trimmer to Stud 26
Concrete Nailing 26
Nail Bearing & Nonbearing
Walls to Floor Perpendicular to Joists 27
Nail Bearing & Nonbearing
Walls to Floor Parallel to Joists 27
Nail Header to Stud 28
Nail Let-in Bracing 29
Nail End of Joist 30
Nail Rim Joist 30
Nail Sheathing 31
Nail Built-up Girders & Beams 32
Nail Joist Blocking 32
Nail Lapping Joists 33
Nail Drywall Backing 33
Nail Trusses to Wall 34
Nail Ceiling Joist, Rafters, & Ridge 34
Nail Rafters to Wall 35
Nail Blocks 35
Nail Fascia & Bargeboard 36

Chapter Two

NAILING PATTERNS

If you are framing every day, the nailing patterns in this chapter will soon become second nature. For the part-time framer, they can serve as a quick reference.

Building codes and generally accepted practices were followed in developing the nailing patterns in this chapter. When the plans call for other nailing patterns, however, be sure to follow them.

You will notice in this chapter that there are different nails specified for the same nailing. There are many different styles of nails. The five most frequently used categories are:

- Common nails
- Box nails
- Sinker nails
- Gun nails
- Positive placement nails

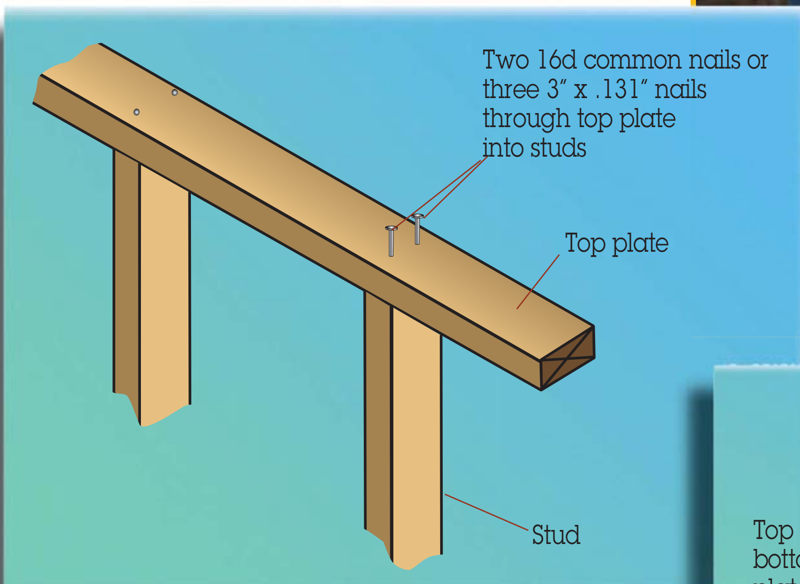
You will see a 3" × .131" nail specified frequently. This nail is the most common P-nail, or pneumatic gun nail, used.

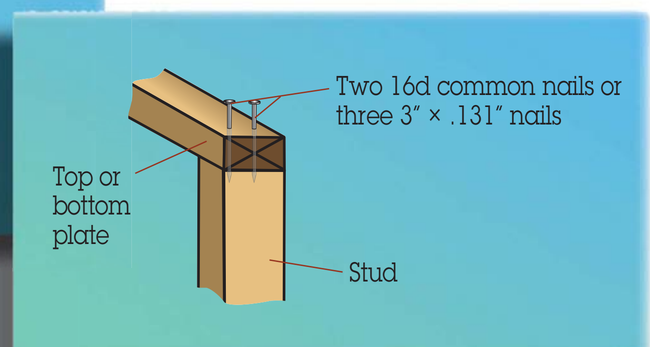
The common nails are listed because they are typically specified by building codes. Most of the tests that are done to determine the strength needed use common nails. Box nails and sinker nails are listed because they are easier to nail, and less likely to split the wood. They are also commonly found at nail suppliers. The gun nails are listed because nail guns are used most often. Positive placement nails are made specially for nailing on hardware. They only work in positive placement nail guns.

Please note that common nails are listed with "common" written after the size. If the nail size has "common" after it, you can only use common nails. If it does not, you can use either common, box, or sinker nails.

The *International Residential Code* (IRC) is similar to the *International Building Code* (IBC) except it only covers one- and two-family dwellings. The patterns in this chapter are based on the 2009 IBC, which, in some cases, requires larger nails than the 2009 IRC.

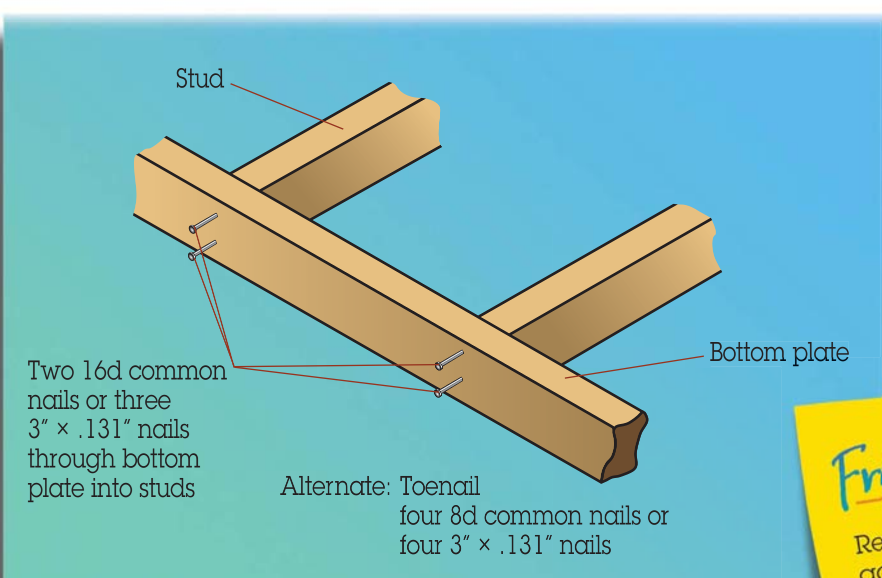
Nail Top Plate to Studs





This illustrates the nailing pattern for fastening studs to the top plate when the wall is in an upright position.

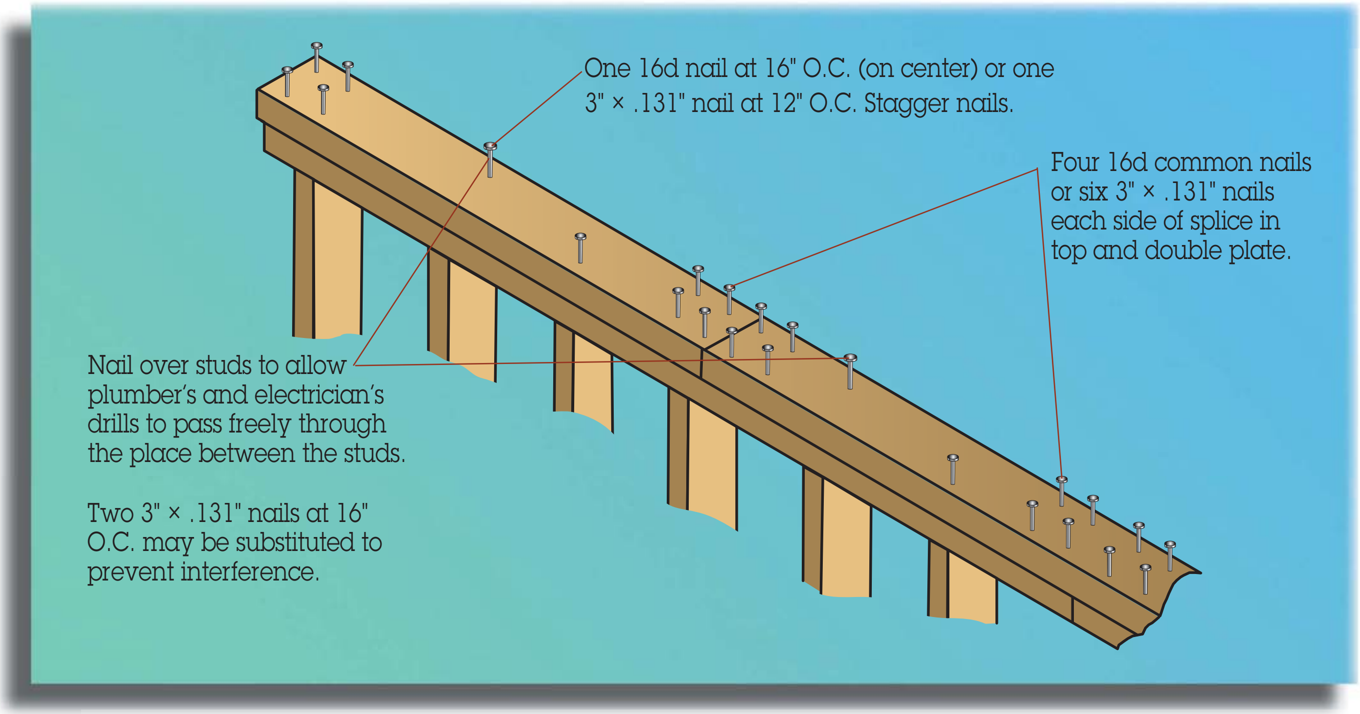
Nail Bottom Plate to Studs



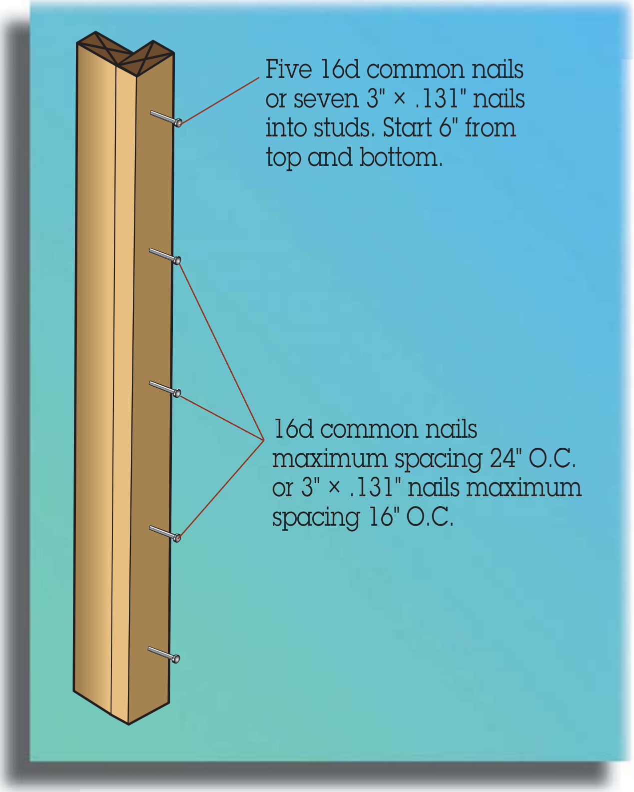
Framer-Friendly Tips

Remember to use hot-dipped galvanized nails if your bottom plate is treated with ACQ or CA.

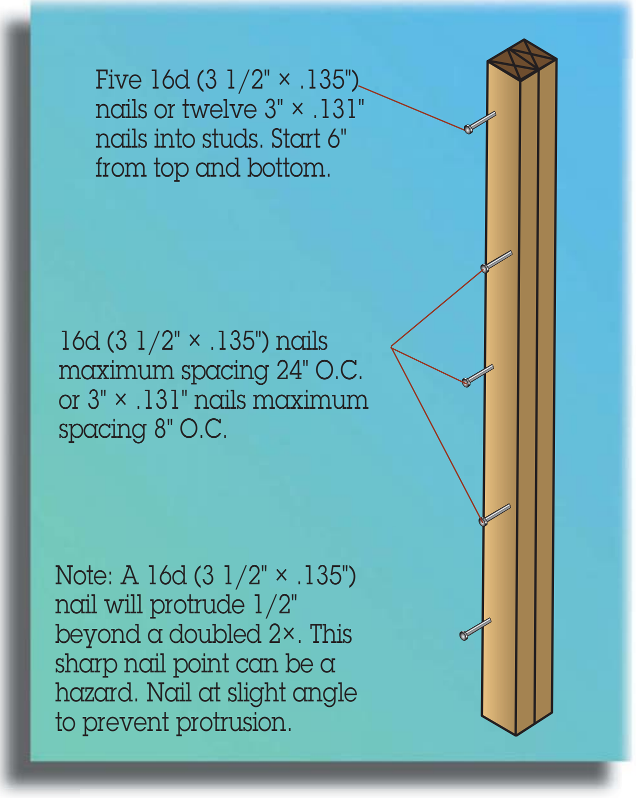
Nail Double Plate to Top Plate



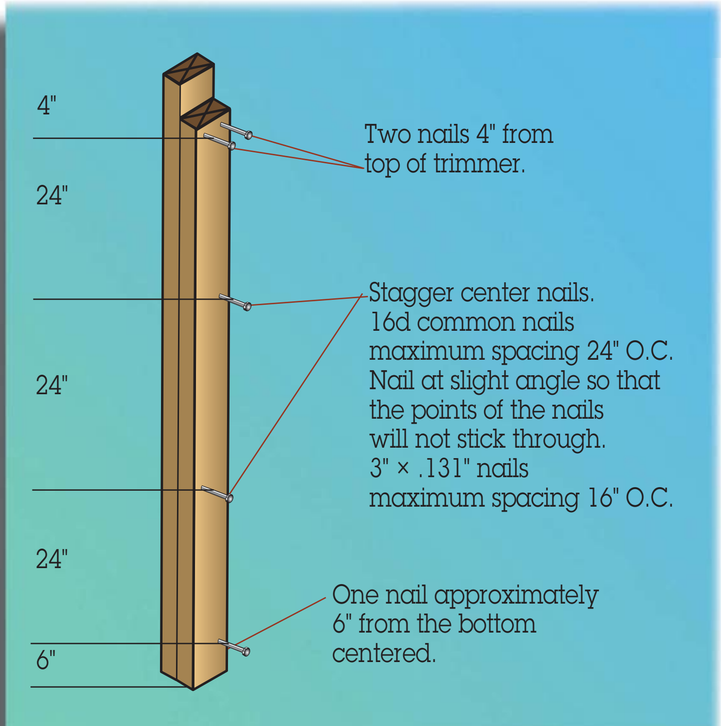
Nail Corner



Nail Walls Together or Nail Double Studs



Nail Trimmer to Stud

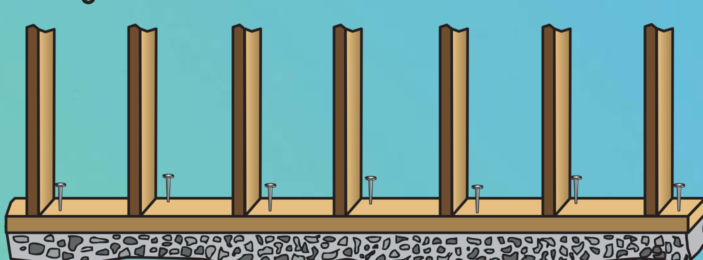


Concrete Nailing

Framer-Friendly Tips

PATs (powder accuated tools) use a controlled explosion similar to firearms and shoot specially hardened steel nails. They make nailing easy, but noisy.

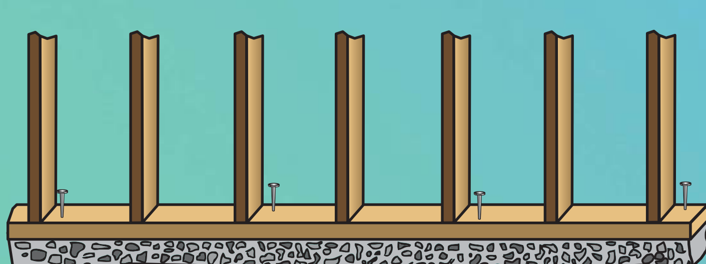
Bearing Walls



One 2½" concrete nail at 16" O.C., or at every stud.

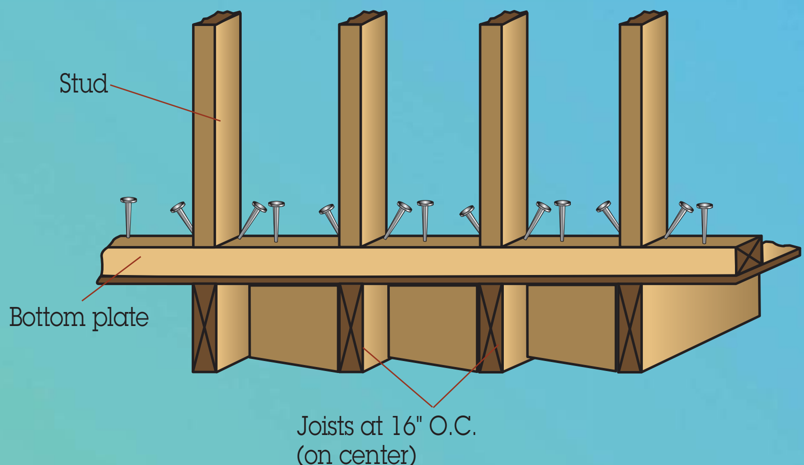
When anchor bolts are used to secure the bottom plate to the concrete, concrete nails are only needed between the anchor bolts when necessary to straighten the plate or secure the ends of the plate.

Nonbearing Walls



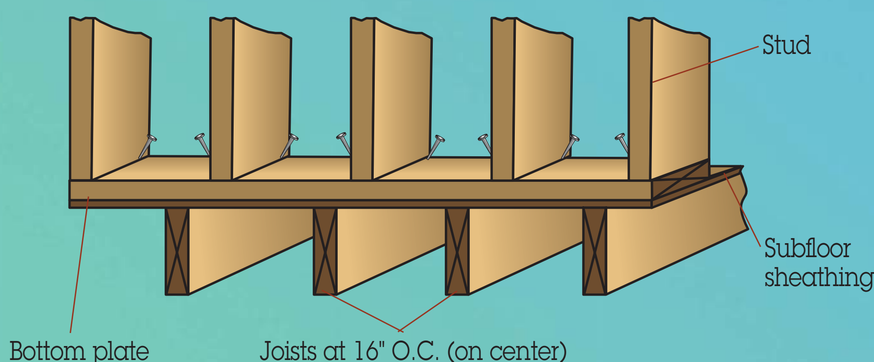
One 2½" concrete nail at 32" O.C., or at every other stud.

Nail Bearing & Nonbearing Walls to Floor Perpendicular to Joists



Bearing Walls

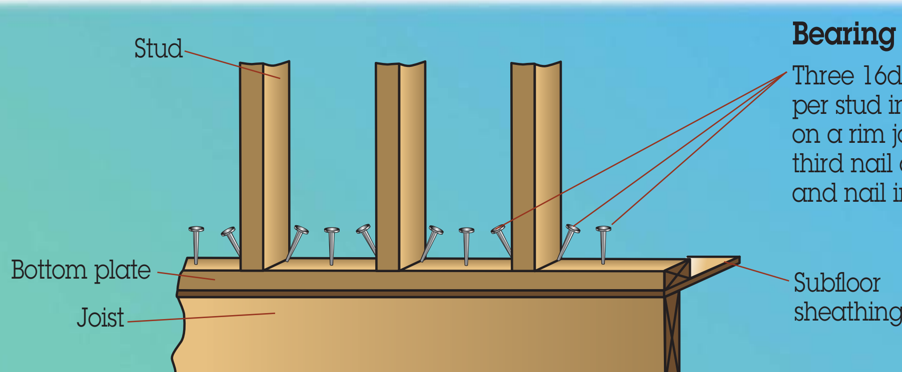
Three 16d nails
or 3" × .131" nails
into each joist.
If wall sits on a rim joist
or blocking, place third nail
at center of joist space
and nail into rim or block.



Nonbearing Walls

One 16d nail
into each joist or
two 3" × .131" into
each joist.

Nail Bearing & Nonbearing Walls to Floor Parallel to Joists



Bearing Walls

Three 16d nails or 3" × .131" nails per stud into each joist. If wall rests on a rim joist or blocking, place third nail at center of joist space and nail into rim or block.

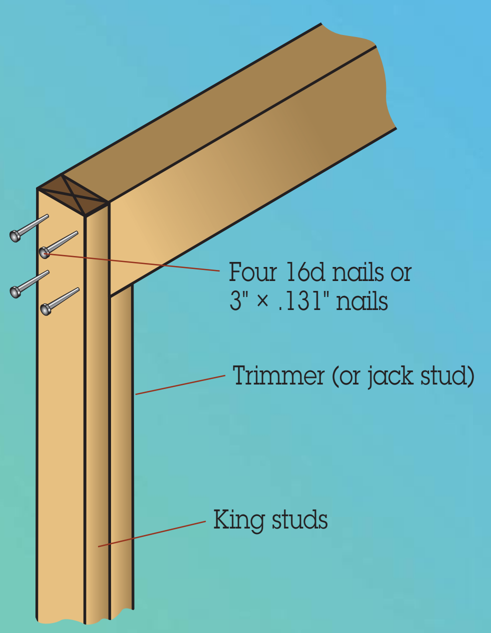
Nonbearing Walls

One 16d nail
into each joist or
two 3" × .131" into
each joist.

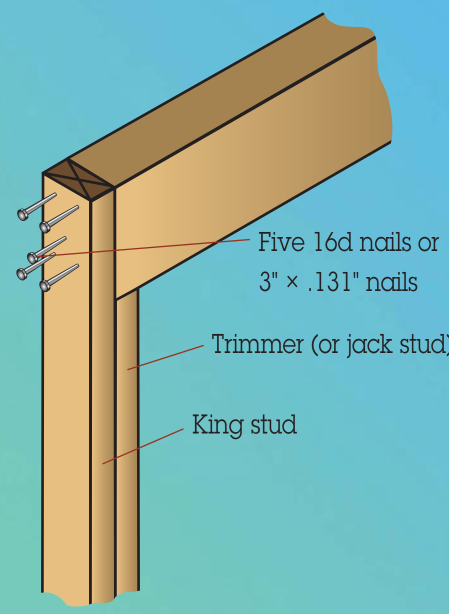
Braced wall panels nailed with same pattern as bearing walls.

Nail Header to Stud

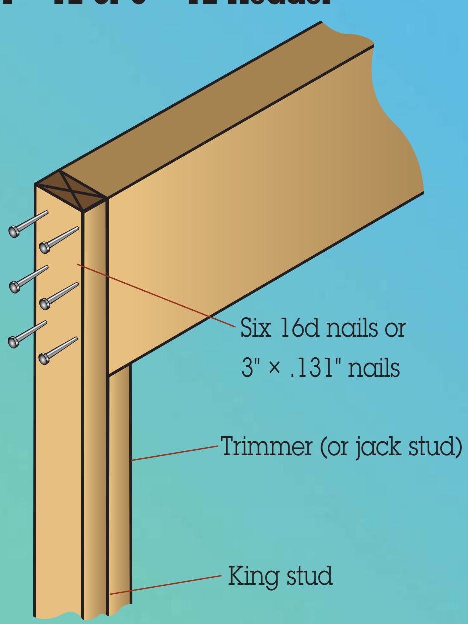
4 × 8 or 6 × 8 Header



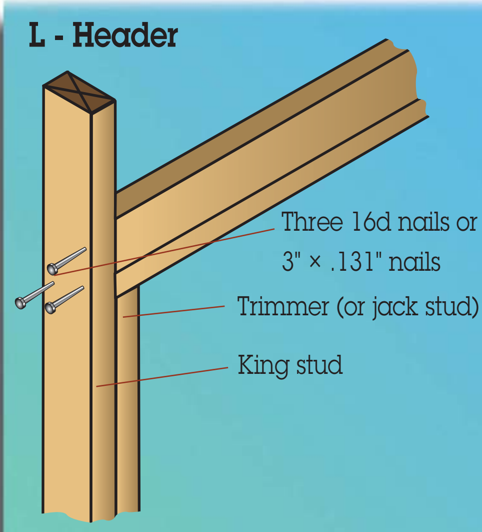
4 × 10 or 6 × 10 Header



4 × 12 or 6 × 12 Header

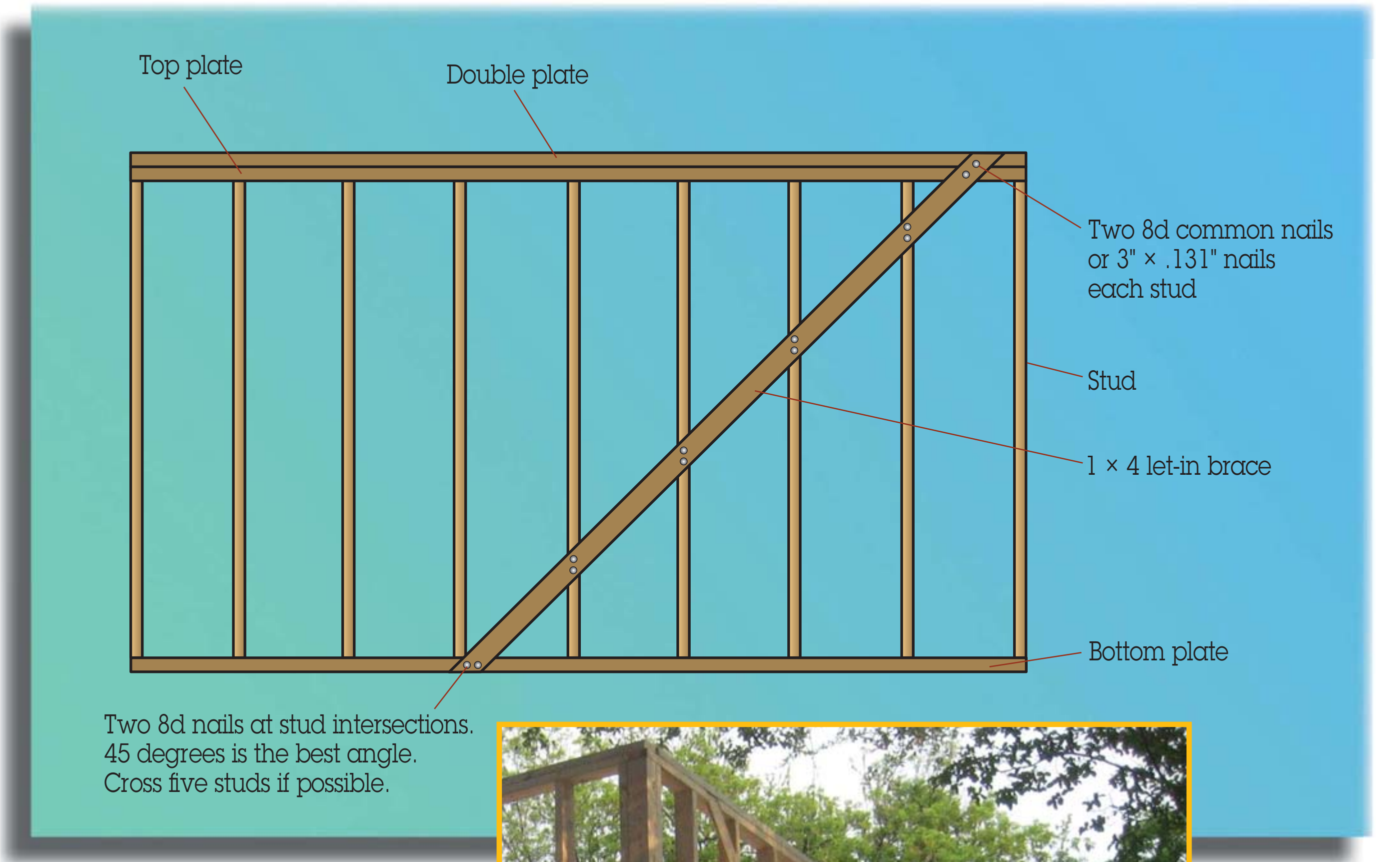


L - Header



Headers made up of 2× lumber with ½" plywood sandwiched between should be nailed similarly.

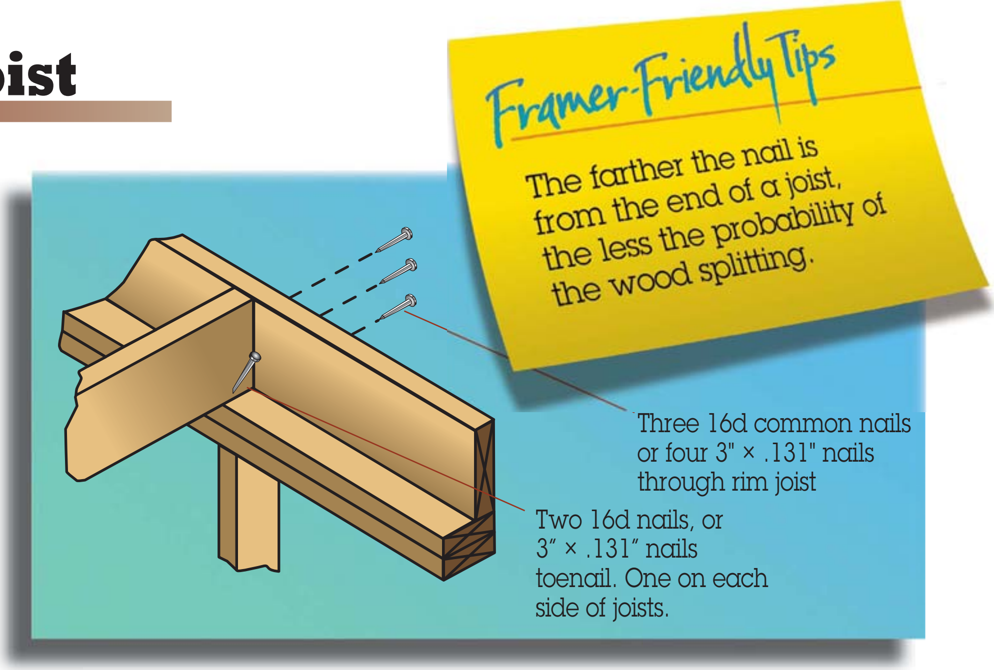
Nail Let-in Bracing



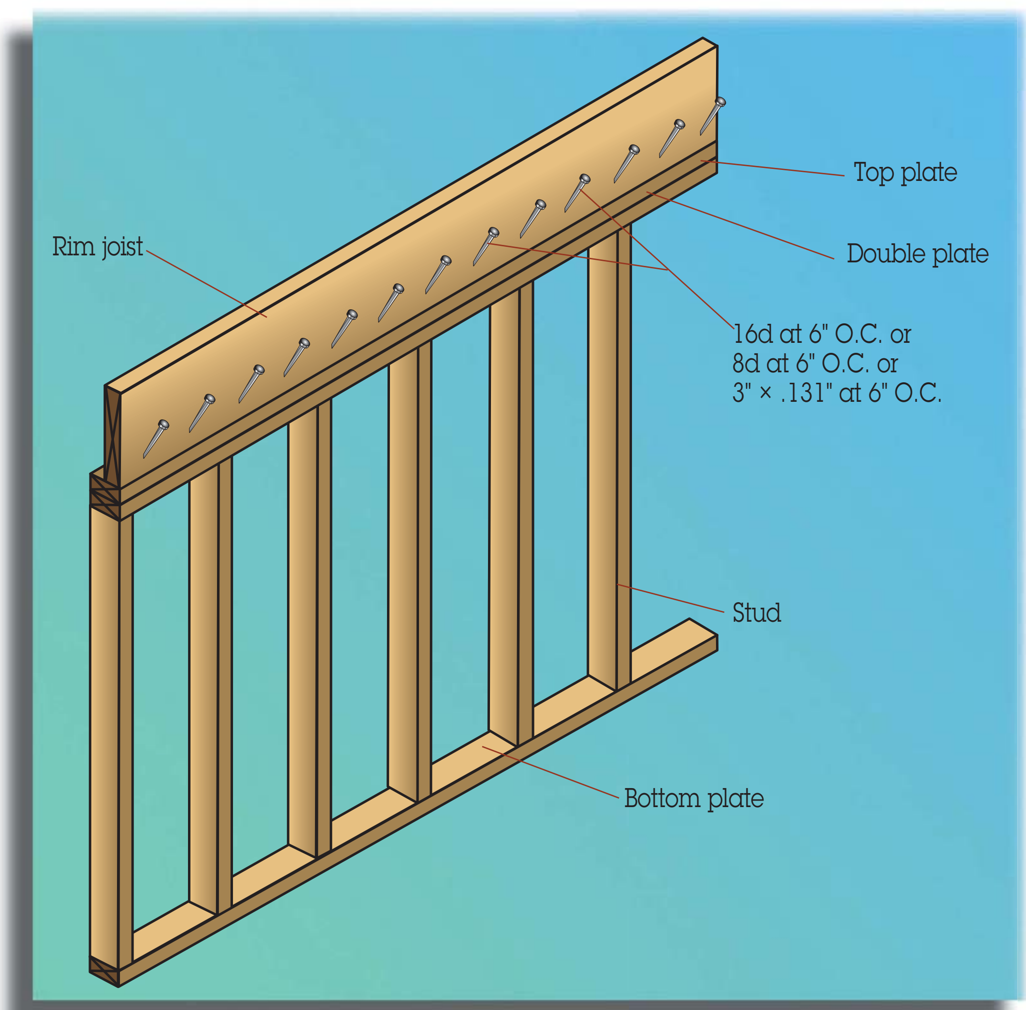
Let-in bracing is installed to prevent "racking" of the wall. Racking in a wall frame occurs when the top plate moves independently from the bottom plate.

Nail End of Joist

This illustration shows the installation of a floor joist on top of the double plate. The rim joist provides not only a good nailing surface, but also a structural component as it spans the space between the studs and prevents lateral rotation of the joists.

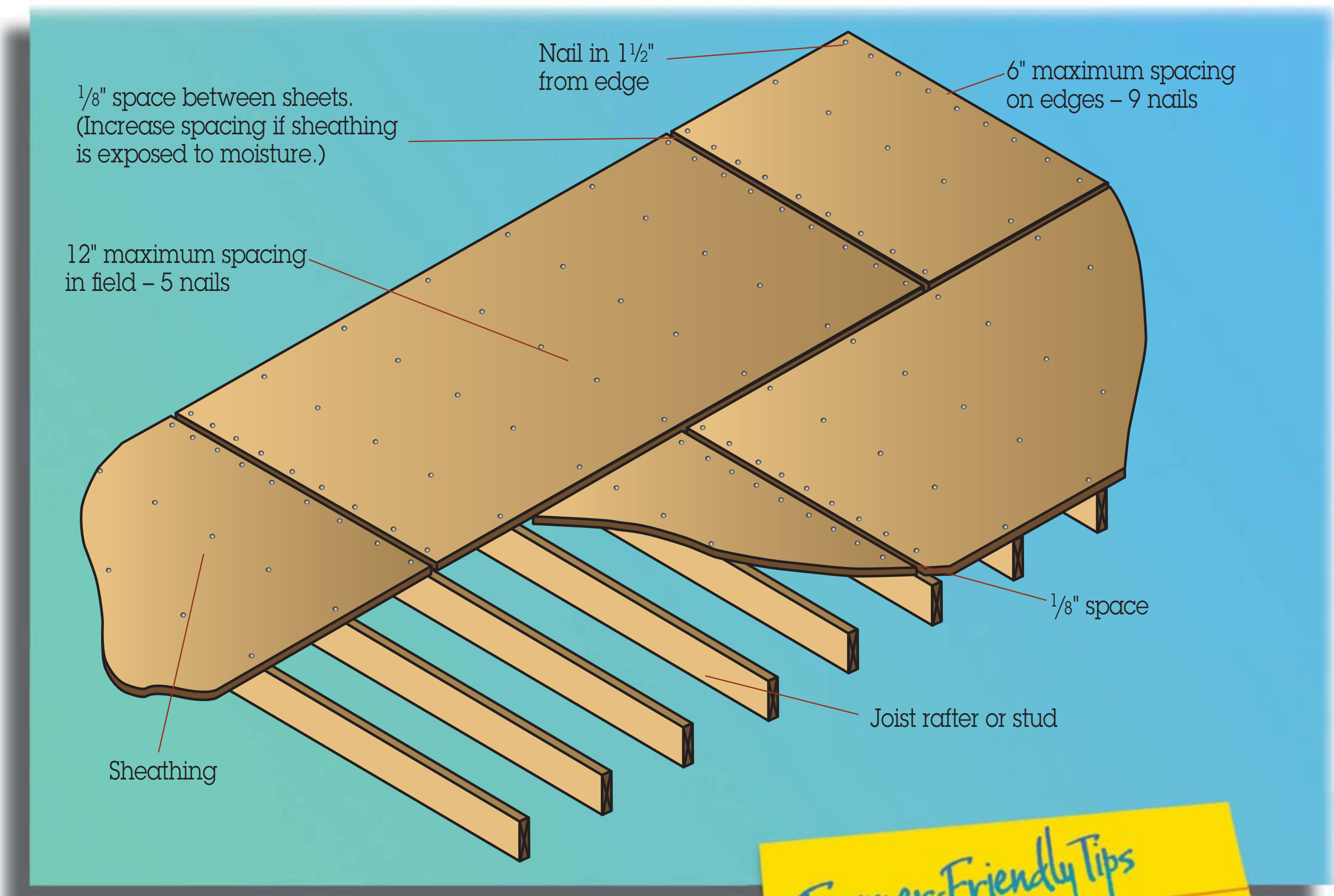


Nail Rim Joist



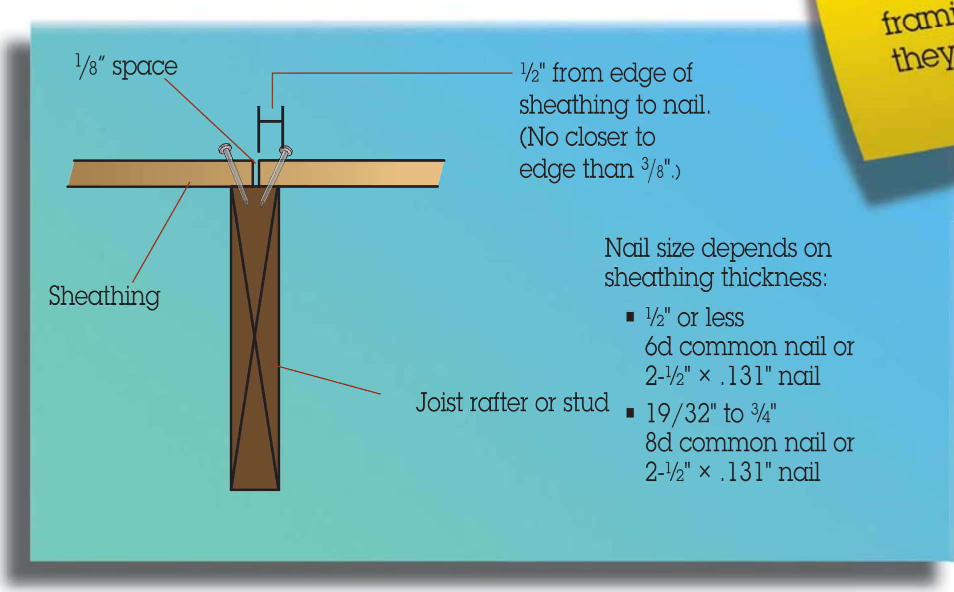
Here the rim joist is being installed. It is a structural component that provides an edge for the building and an attachment for the joists to prevent lateral rotation.

Nail Sheathing



Framer-Friendly Tips

Look under the sheathing to check for nails that missed the framing and are touching joists – they might cause squeaking.

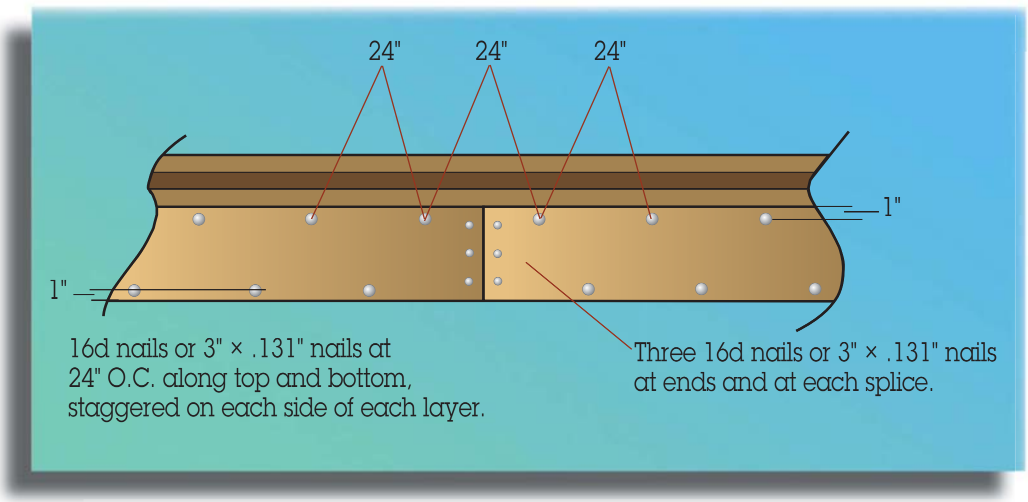


Nail size depends on sheathing thickness:

- ½" or less
  6d common nail or
  2-½" × .131" nail
- 19/32" to ¾"
  8d common nail or
  2-½" × .131" nail

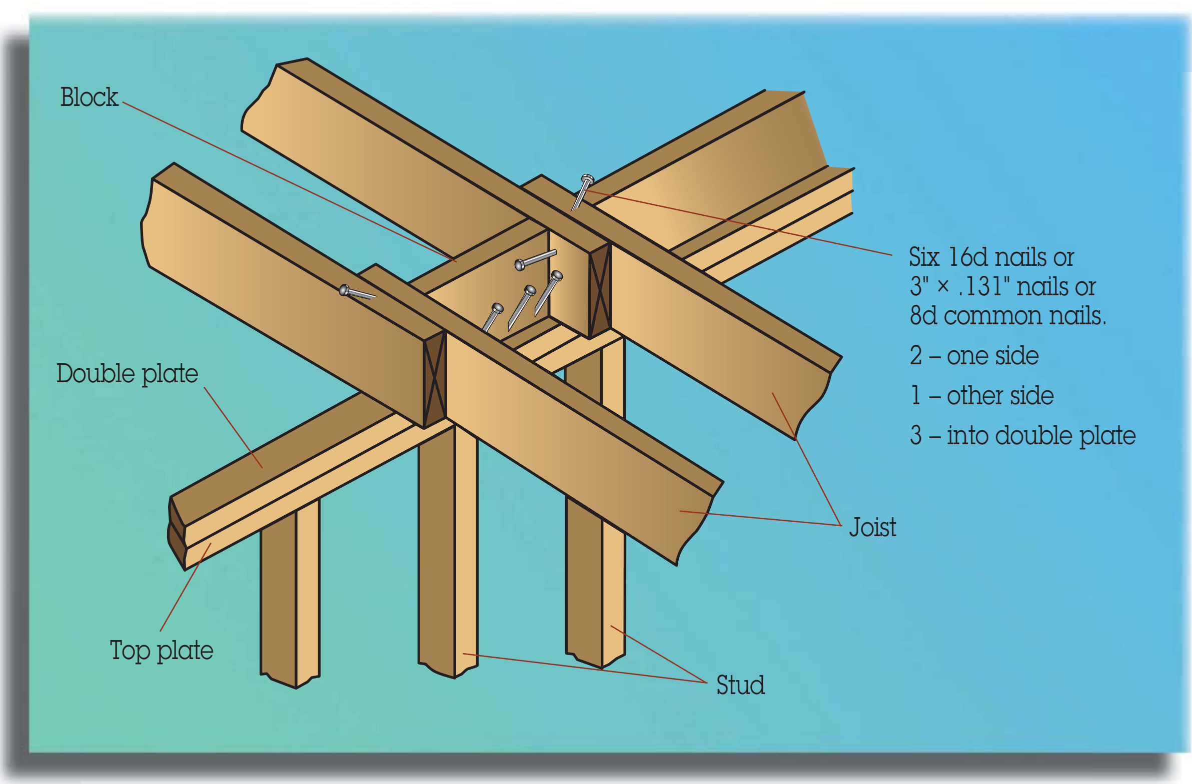
Mark stud/joist/rafter spacing on the sheathing and then align the framing component with the mark before nailing. This ensures straight, evenly spaced framing.

Nail Built-up Girders & Beams



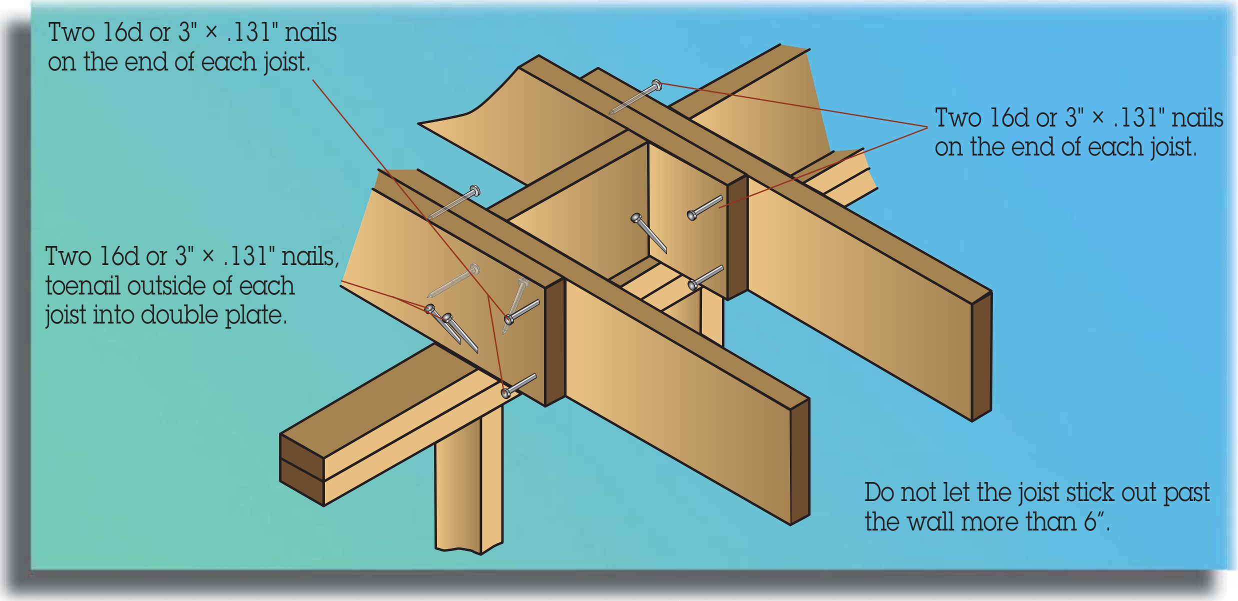
Make sure edges are aligned when nailing girders and beams together.

Nail Joist Blocking

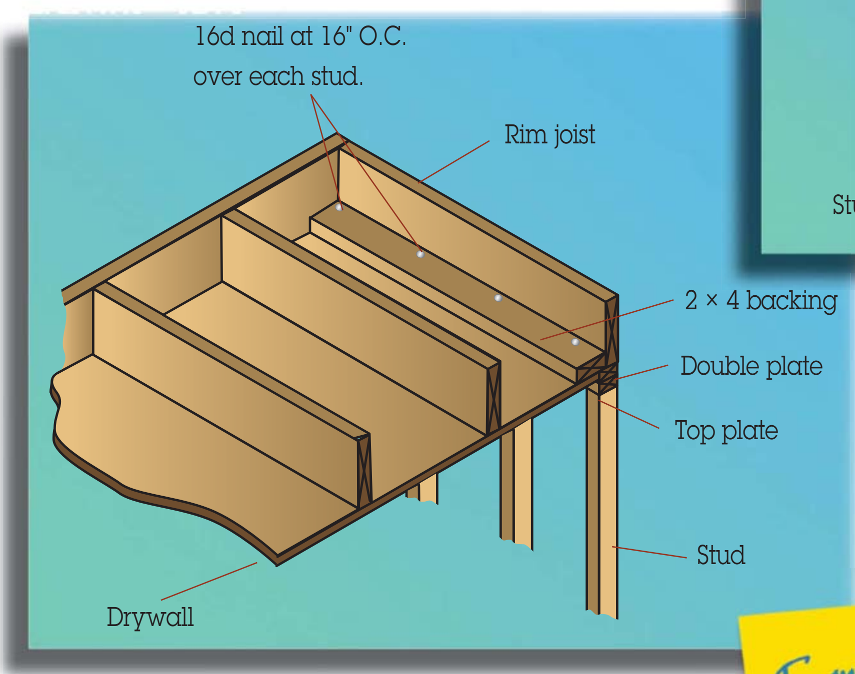


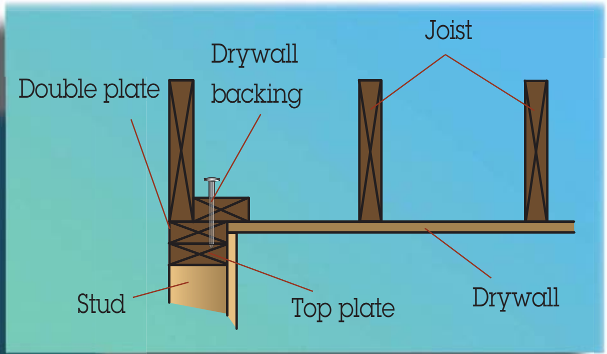
Blocking helps align joists, transfers loads, and provides fire protection. The right size block will tighten up the joists without moving them.

Nail Lapping Joists



Nail Drywall Backing



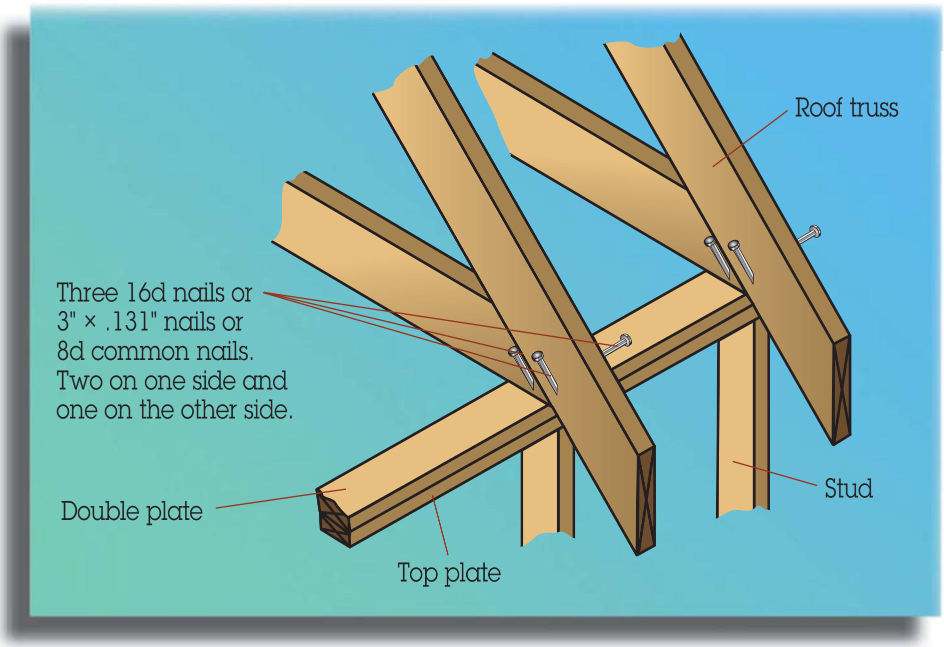


Framers will often install backing and blocking that is used by other contractors. Backing for fastening gypsum wallboard is a good example.

Framer-Friendly Tips

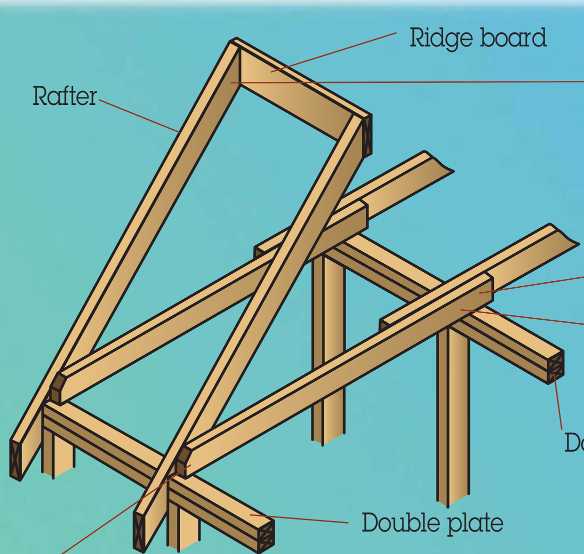
Install backing for ceiling before sheathing floor.

Nail Trusses to Wall



The installation of roof trusses may require the use of a crane or boom truck to lift and position the trusses.

Nail Ceiling Joists, Rafters, & Ridge



Connecting rafter to ridge board

Two 16d common nails or
three 3" × .131" nails,
toenail or face nail.

Connecting lapped ceiling joists to each other and to wall

Connecting ceiling joists
Three 16d common nails or
four 3" × .131" nails

Ceiling joists to double plate
Three 16d nails or
three 3" × .131" nails or
three 8d common nails

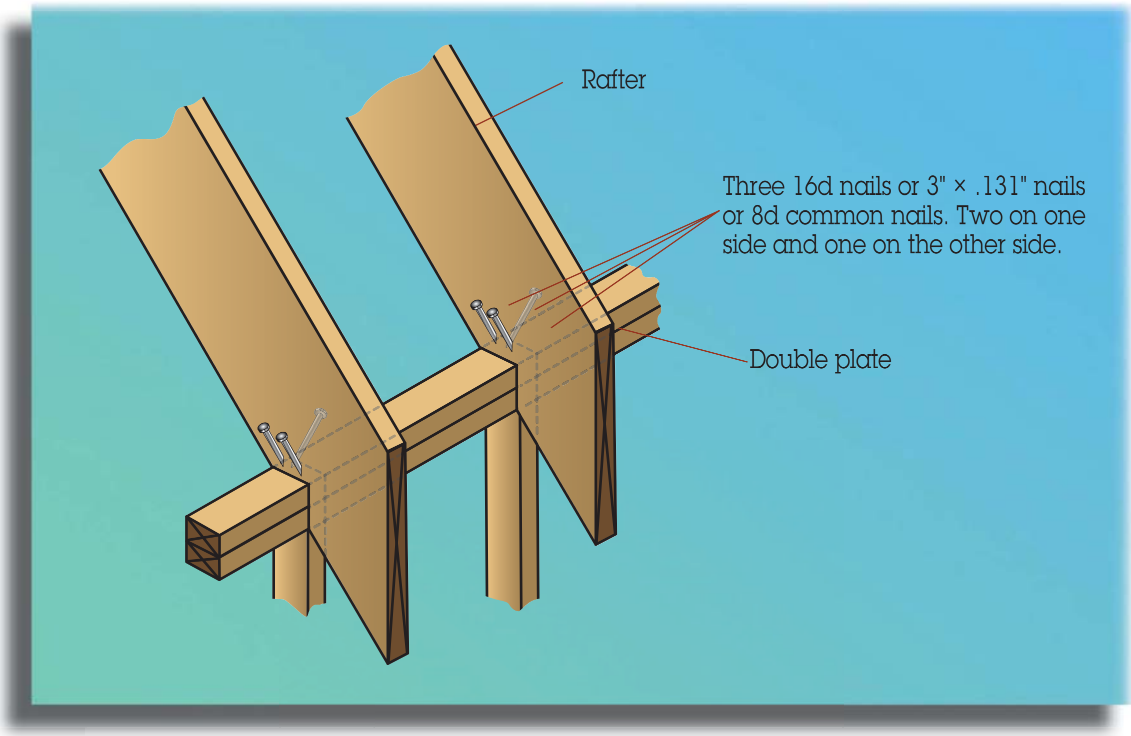
Connecting ceiling joists to rafter to wall

Join ceiling joists and rafters
Three 16d common nails or four 3" × .131" nails

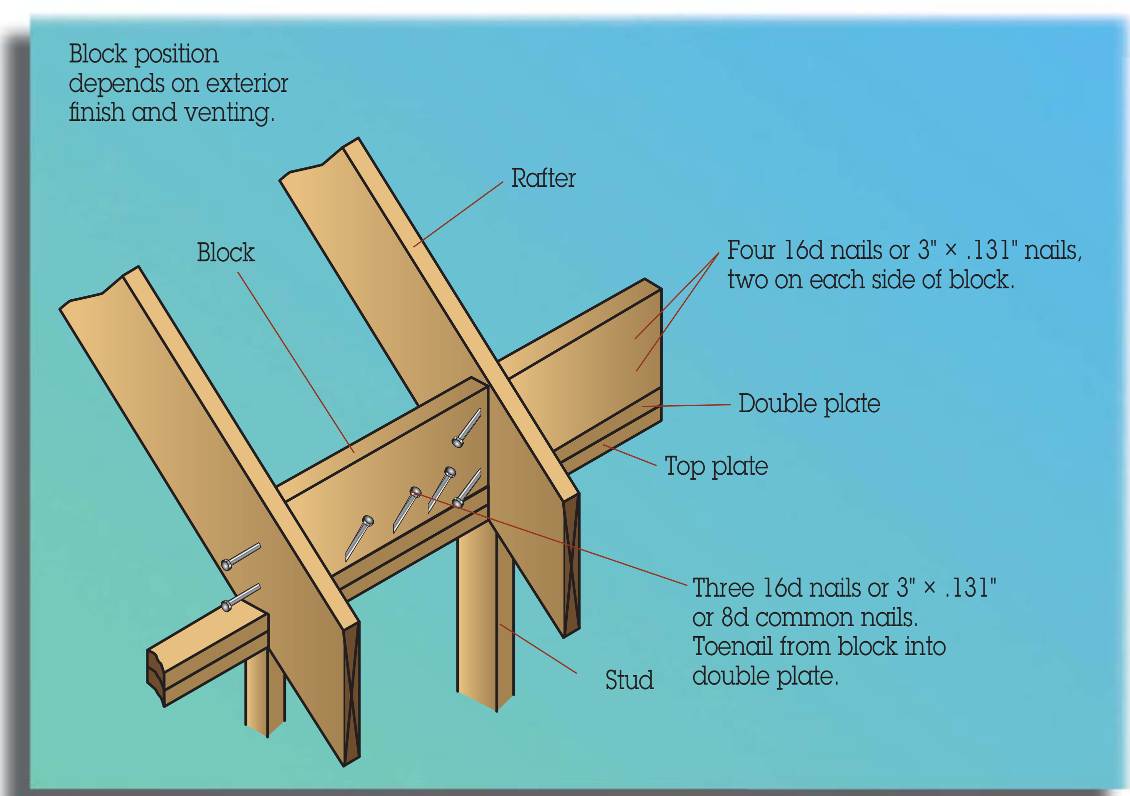
Toenail from ceiling joists into double plate
Three 16d nails or three 3" × .131" nails or three 8d common nails

Toenail from rafter into double plate
Three 16d nails or 3" × .131" nails or 8d common nails

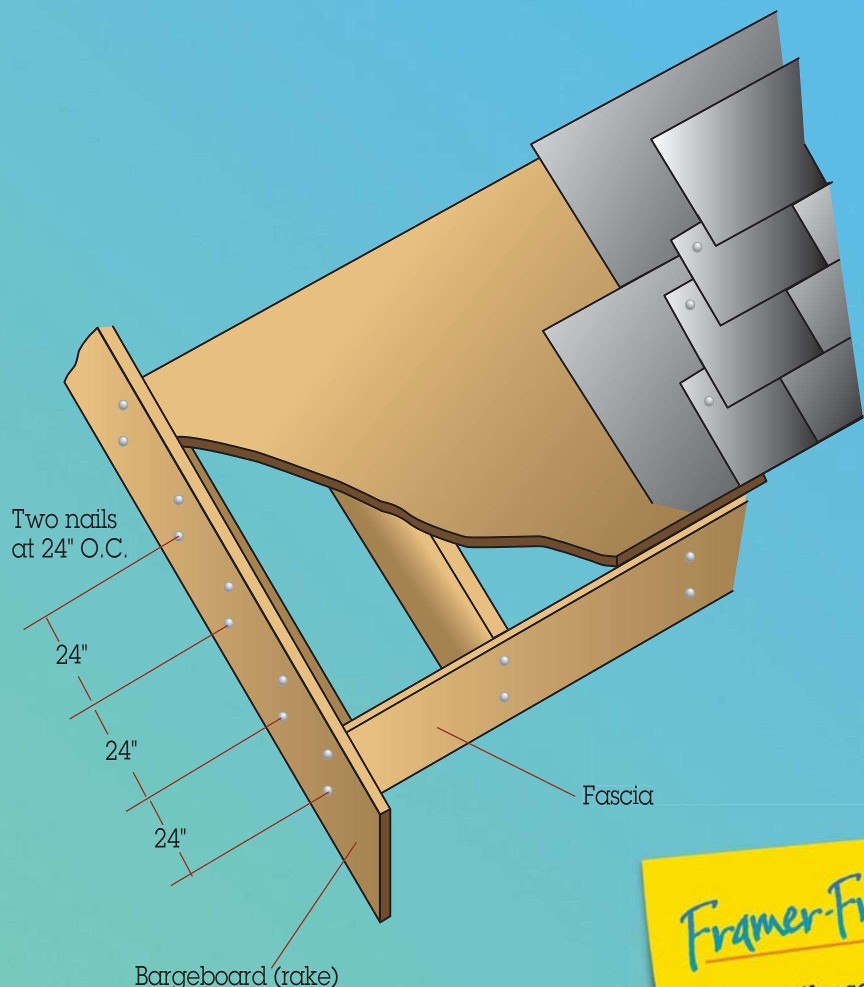
Nail Rafters to Wall



Nail Blocks



Nail Fascia & Bargeboard



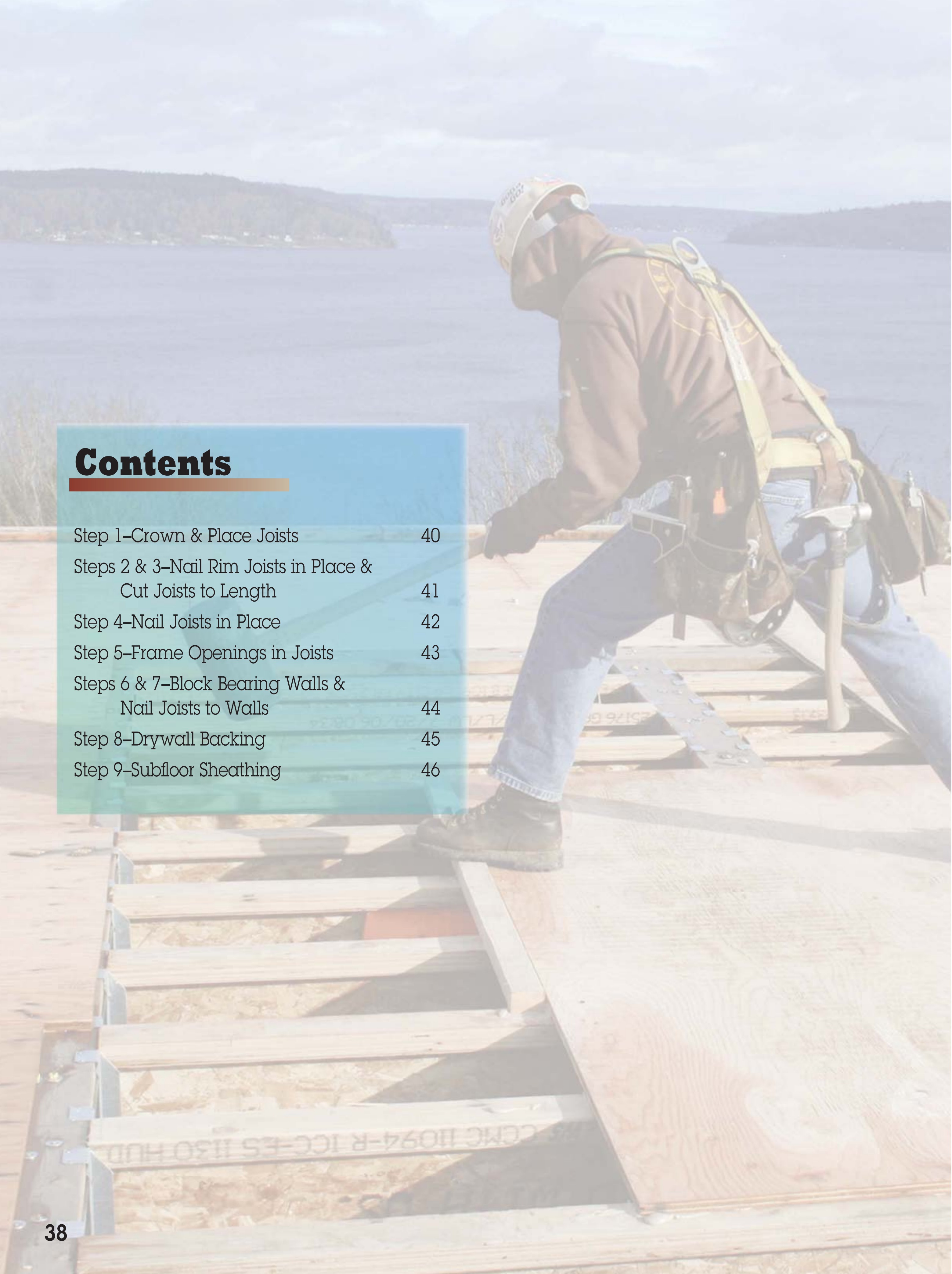
- 1" fascia – use 8d galvanized box nails
- 2" fascia – use 16d galvanized box nails

Framer-Friendly Tips

Since these nails are exposed, pay particular attention to making the distances consistent in the nailing patterns.

Framers (and the eventual homeowner) like to have the roof installed as soon as possible. The roofing provides a dry workspace and protects all the installed framing from the weather. Be careful not to leave hammer head marks in the fascia, since it is a finish product.

Chapter Three
FLOOR FRAMING



Contents

Step 1–Crown & Place Joists	40
Steps 2 & 3–Nail Rim Joists in Place & Cut Joists to Length	41
Step 4–Nail Joists in Place	42
Step 5–Frame Openings in Joists	43
Steps 6 & 7–Block Bearing Walls & Nail Joists to Walls	44
Step 8–Drywall Backing	45
Step 9–Subfloor Sheathing	46

Chapter Three

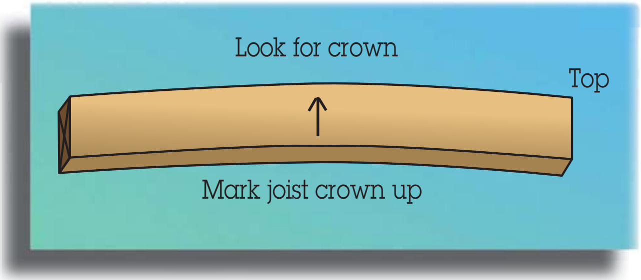
FLOOR FRAMING

This chapter illustrates the basic sequence for floor framing. Straight cuts and tight nailing make for a neat and professional job. Pay particular attention to the corners. It is important that they stay square and plumb up from the walls below, so the building does not gain or lose in size. Also pay close attention to laying the first sheet of subfloor sheathing. If it is laid straight and square, the entire subfloor will go down easily and you can avoid making extra cuts. If you make a sloppy start on the first sheet, you'll struggle to make each sheet fit, you'll waste valuable time, and you won't be proud of the results.

Step 1–Crown & Place Joists

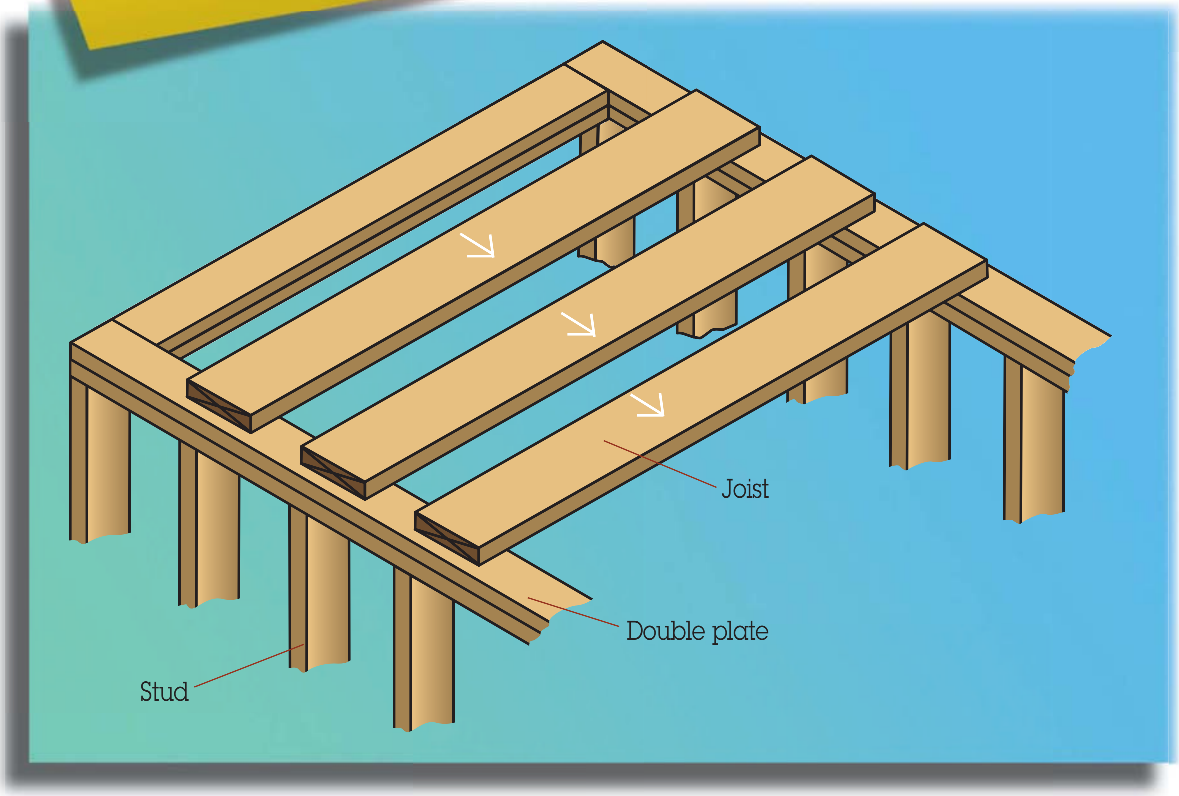
Spread joists so crowns are in the same direction. The crown is the highest point of a curved piece of lumber.

If the joists are resting on a foundation instead of a stud wall, then a sill plate, or mudsill, would be attached to the foundation, and the joists would rest on the plate or sill.



Framer-Friendly Tips

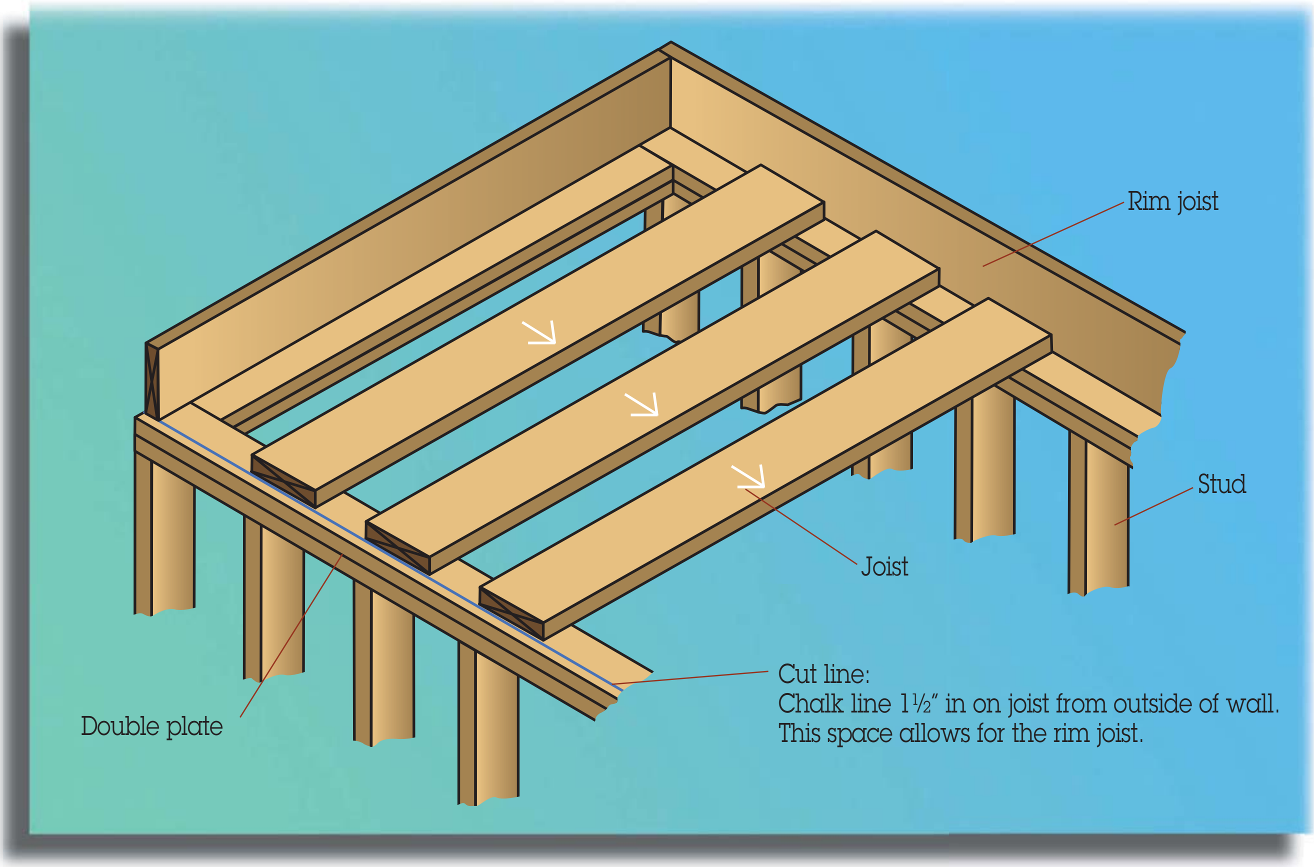
Marking the joists as you crown them–showing the crown direction–prevents mistakes or re-crowning.



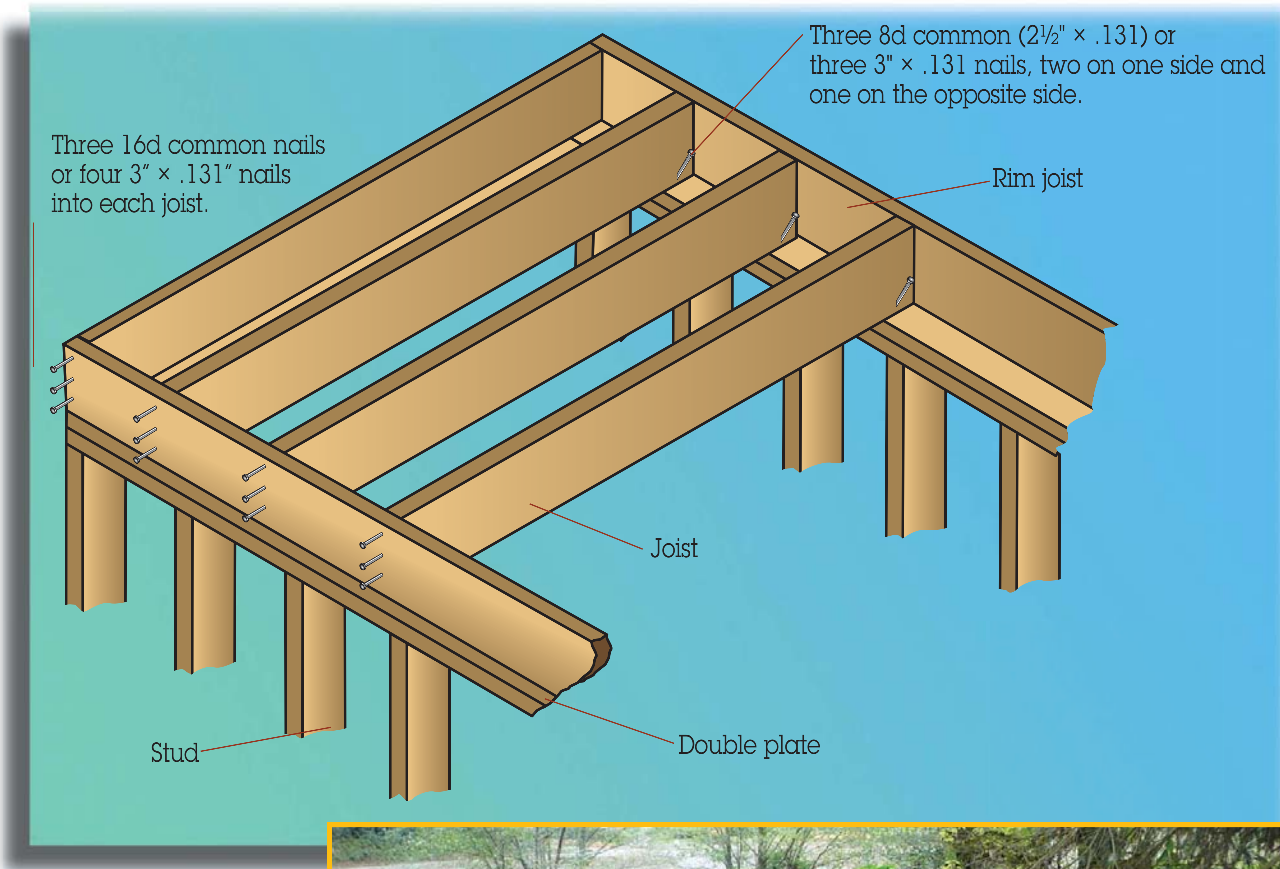
Steps 2 & 3–Nail Rim Joists in Place & Cut Joists to Length

Joist spread and marked, ready to cut

If joists lap over an interior wall, they can be rough-cut approximately two inches beyond the wall. Do not let lapped joists go more than six inches beyond the wall.

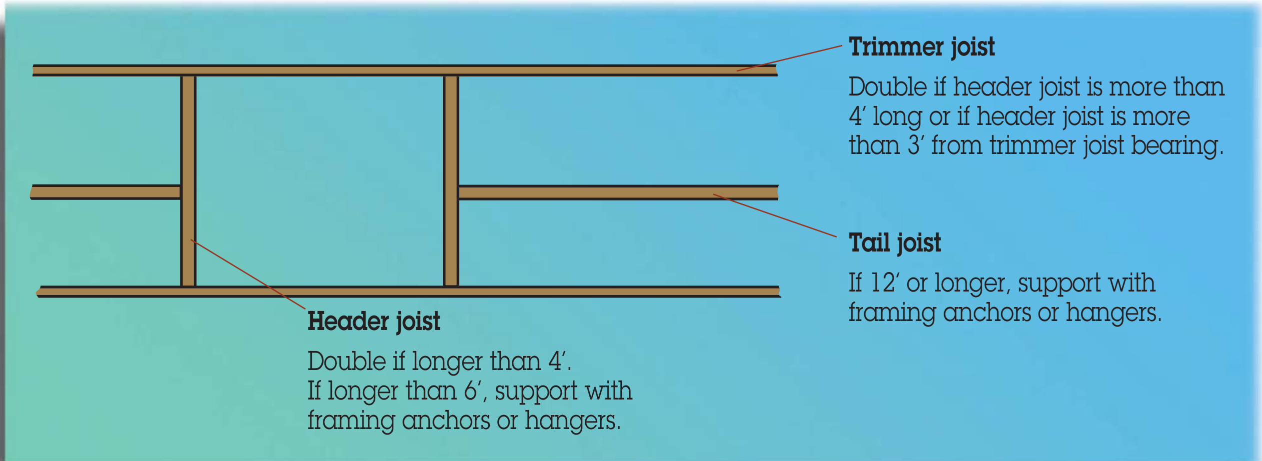


Step 4–Nail Joists in Place

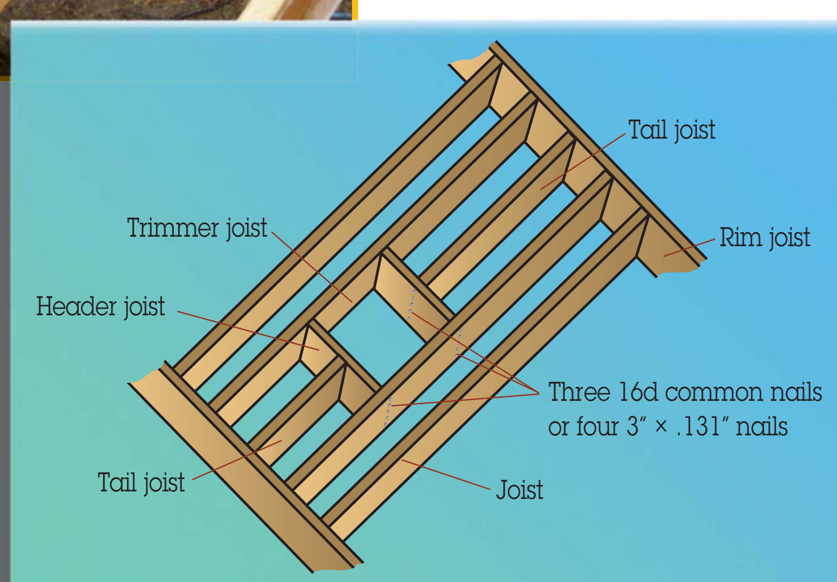


Turn joists crown up and nail into place.

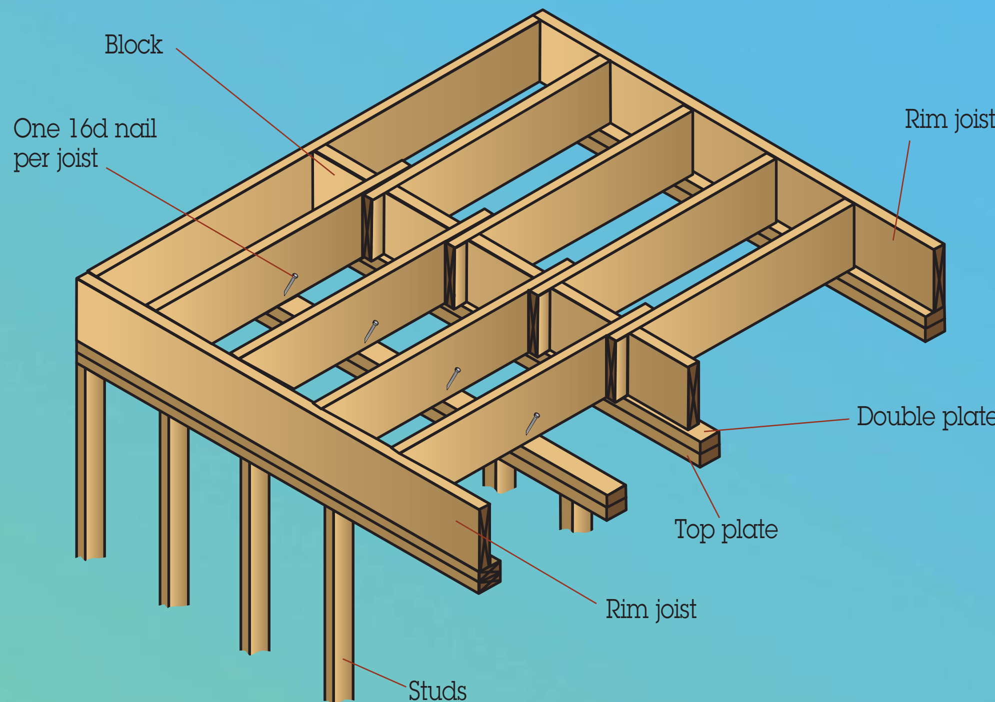
Step 5–Frame Openings in Joists



This is a crawl space access typically found in a closet or some other out-of-the-way location. Mark the floor sheathing as you install it so you don't cover the crawl space access.



Steps 6 & 7–Block Bearing Walls & Nail Joists to Walls



Cutting Blocks

16″ O.C. spacing
- Single joist blocks — 14 7/16″
- Lapped joist blocks — 12 7/8″

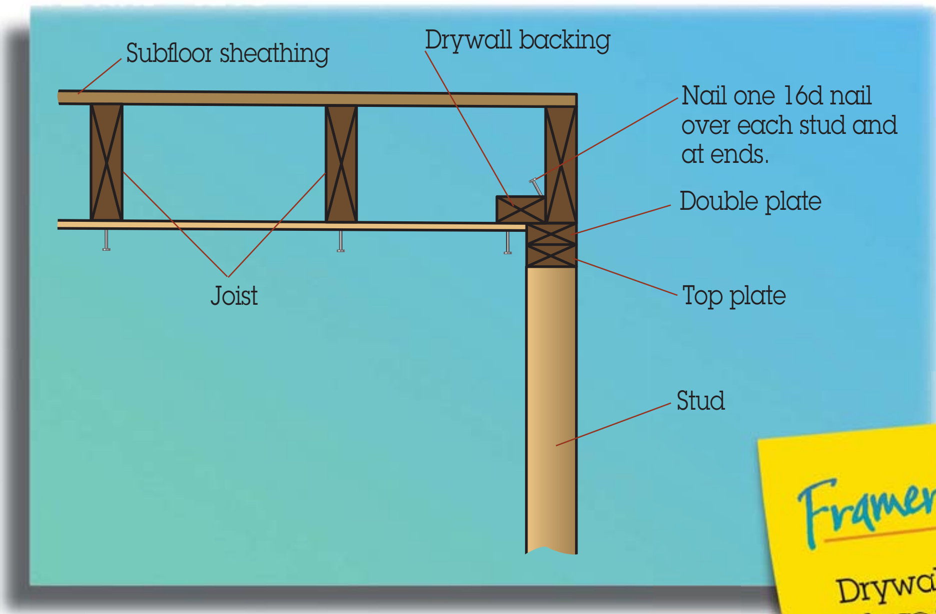
24″ O.C. spacing
- Single joist blocks — 22 7/16″
- Lapped joist blocks — 20 7/8″

Framer-Friendly Tips

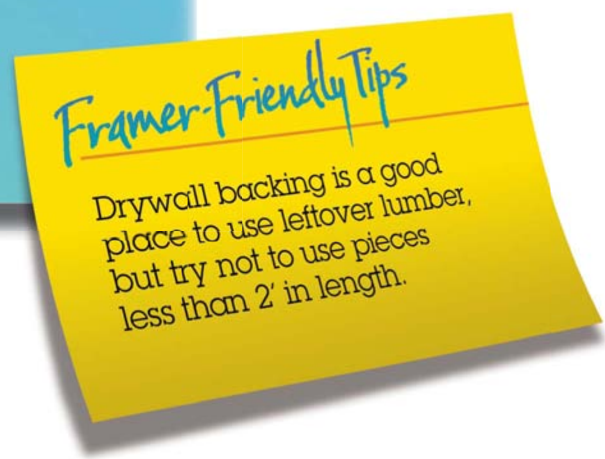
The right size block tightens up the joist location. Adjust block sizes as necessary.

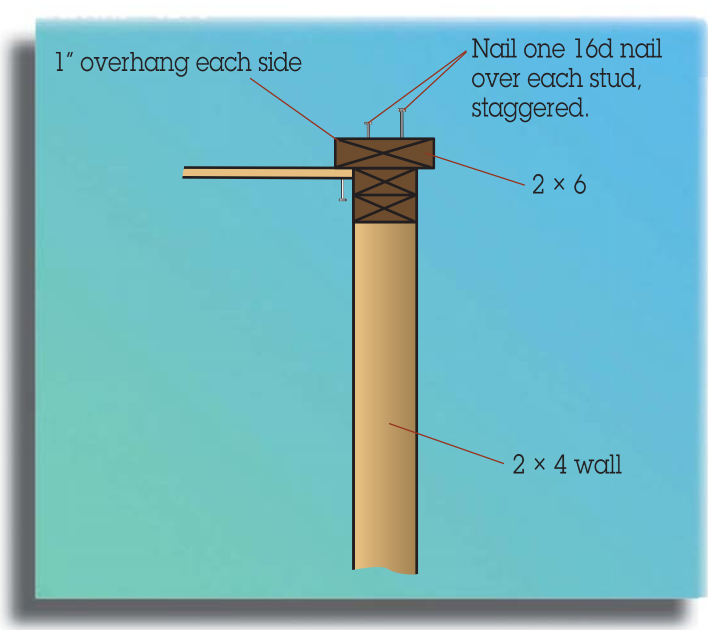
Bearing wall blocks

Step 8–Drywall Backing



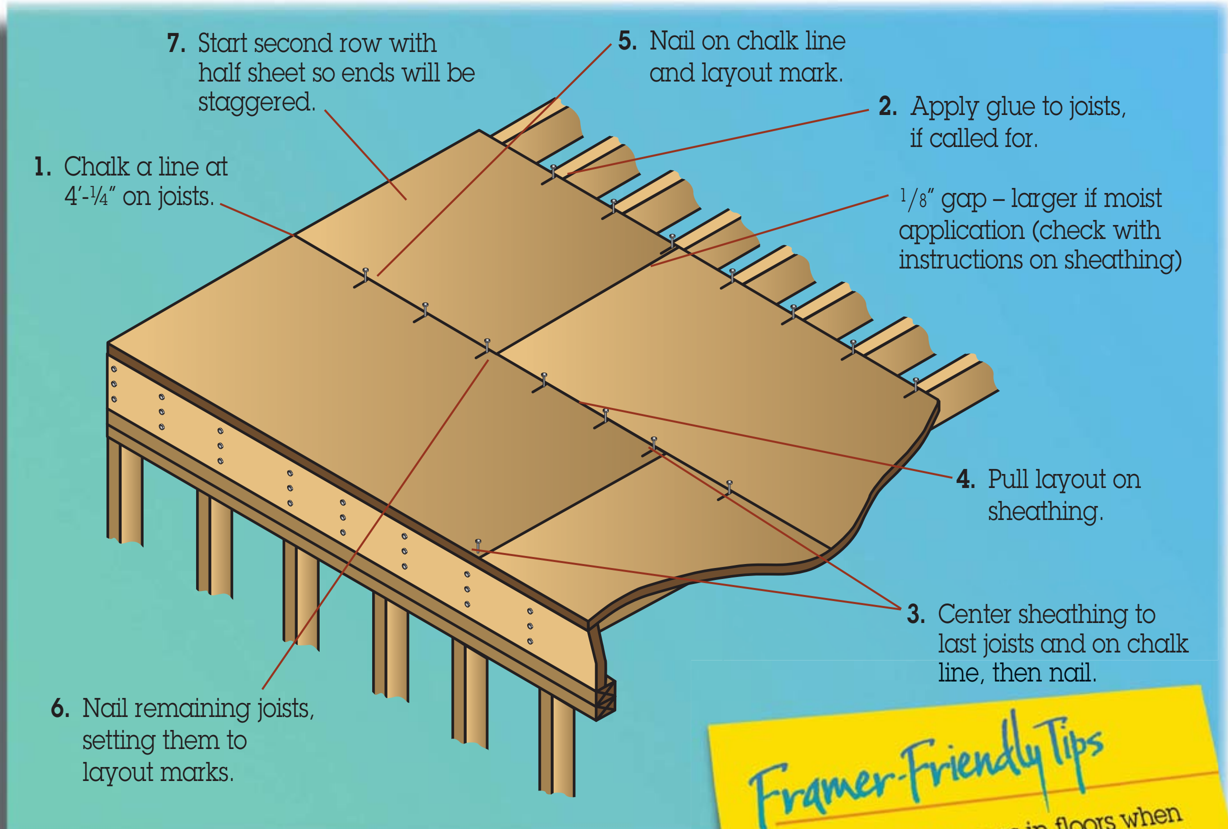
Whenever the distance from the edge of the wall to the joist is greater than 6", place drywall backing on top of the wall.





The width of the 2 × 6 provides for 1" of nailing surface on either side of the 2 × 4 wall.

Step 9–Subfloor Sheathing



Framer-Friendly Tips

Squeaking occurs in floors when a nail is not held tight to the joist through the sheathing. As a result, the nail can move against the joist, which causes a squeak.

Six Steps for Setting First Sheet of Sheathing

1. Snap a chalk line 4'-¼" in from one rim to its opposite, perpendicular to the joists.
2. Apply glue to joists, if called for. Be sure to nail sheathing before glue dries.
3. Center first piece of sheathing to last joist and on the chalk line and nail each end at last joist.
4. Pull joist layout from corner of sheathing and mark sheathing.
5. Nail sheathing to joist next to rim joist along chalk line and layout mark.
6. Set remaining joists to layout marks and nail.

Setting Second Sheet

1. Set to chalk line and layout mark.

Setting Second Row and Remaining Sheets

1. Set to existing sheets, allowing 1/8" gaps.
2. Stagger sheet ends on joists.
3. Make sure rim joists are straight before they are nailed.

Each sheet must be supported by at least 3 joists.

Chapter Four
WALL FRAMING

Contents

Step 1–Spread Headers 50
Step 2–Spread Makeup 51
Steps 3–7–Assemble Wall 52
Step 8–Square Wall 53
Step 9–Sheathe Wall 54
Step 10–Install Nail-Flange Windows 55
Steps 11–15–Standing & Setting Wall 56
Step 16–Plumb & Line 57
Framing Rake Walls 60

Chapter Four

WALL FRAMING

There are many ways to frame walls, but it is always good to follow an organized sequence. This 16-step sequence has been developed over years of framing. Following these steps will help you and your crew work efficiently and eliminate errors. It will also ensure consistency from framer to framer. For example, if you have to leave a wall in the middle of framing it to go to another task, another framer can easily pick up where you left off and proceed without having to check every nail to see what you have done.

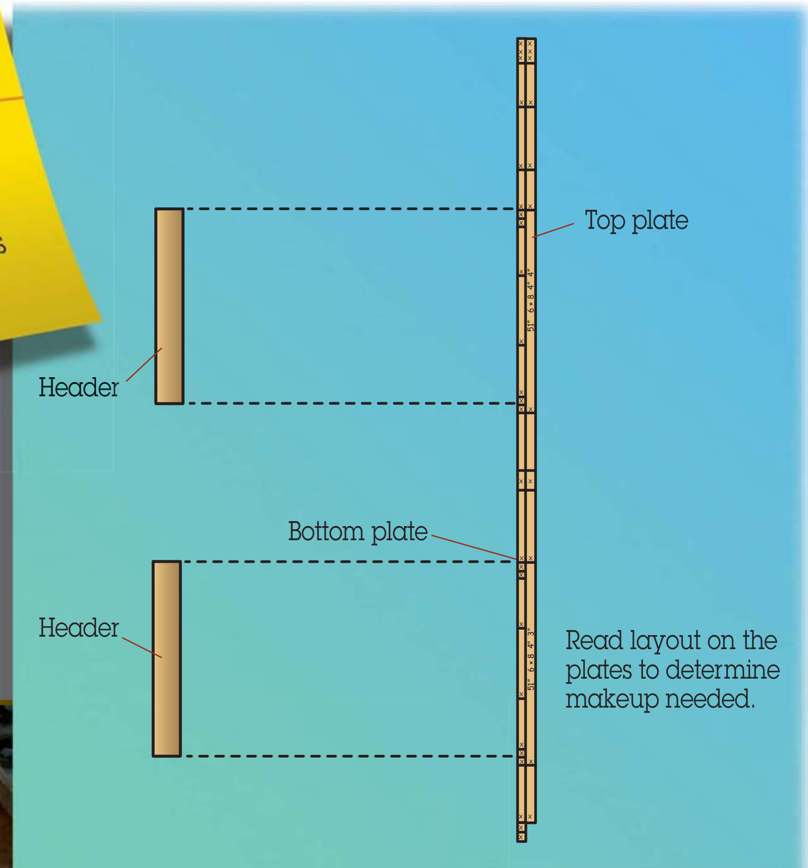
Keep in mind, walls must be square, plumb, and level. Measure accurately, cut straight, and nail tight.

Rake walls (sometimes referred to as *gable end walls*) typically start at the height of the standard wall and go up to the ridge of the roof. The challenge of building a rake wall is figuring the heights of the studs and making sure the wall is built square. Lifting the assembled rake wall into place can also be a challenge. This chapter will cover four ways to figure stud heights and build rake walls efficiently—using methods that will make your work easier.

Step 1–Spread Headers

Framer-Friendly Tips

Locate the headers as close to where they will go as possible, so when you have your nail gun in hand, there's not a lot of moving.

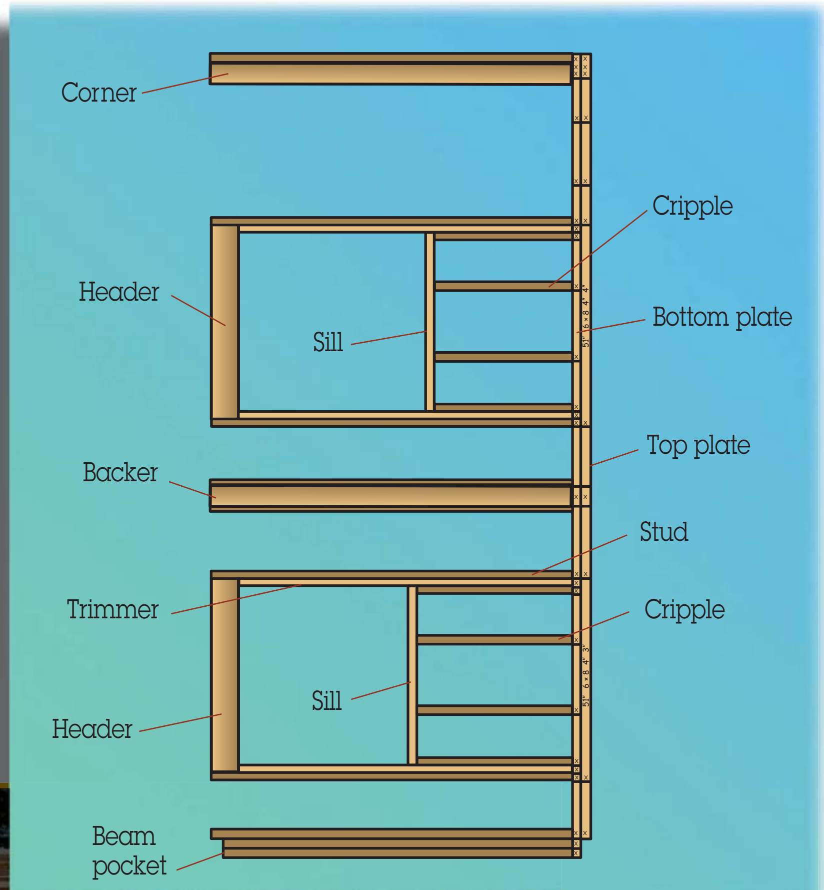


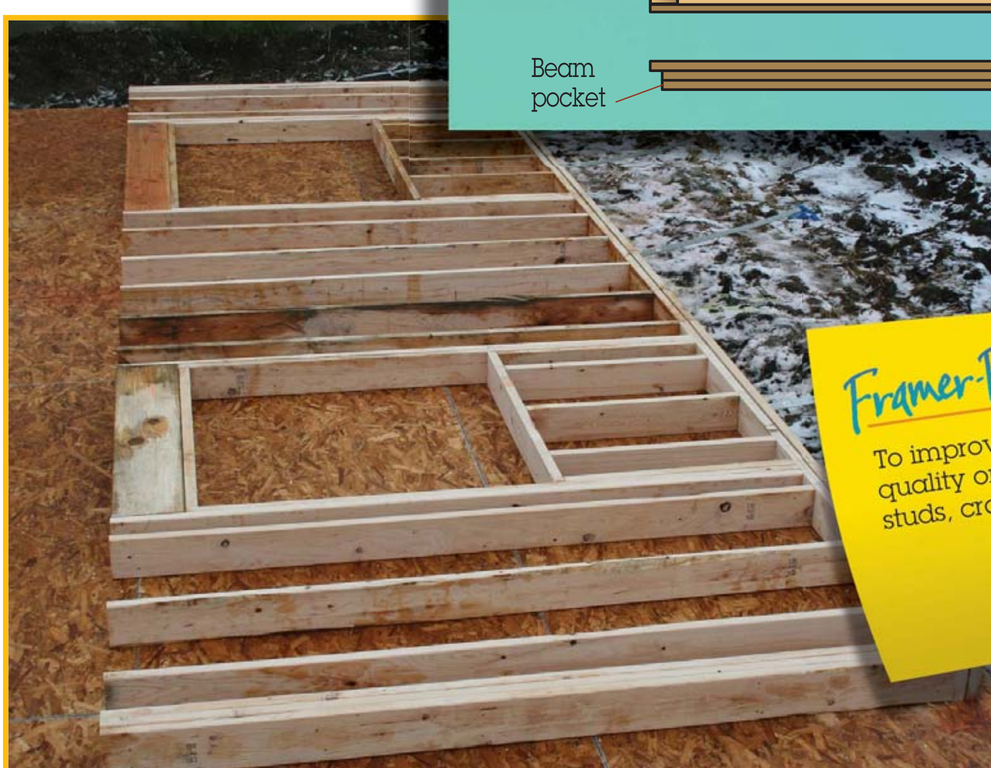
Spread headers in location close to where they will be framed.

The steps outlined in the next pages follow the process of framing and sheathing the exterior walls in a horizontal position. The fully framed and sheathed wall is then lifted into position by using special lifting jacks or muscle power.

Step 2–Spread Makeup

Usually, one member of the framing crew does all the cutting. This promotes an efficient workflow and ensures consistent cuts. The person doing all the cutting must work fast enough to stay ahead of the remaining members of the crew.





Spread makeup: stud/trimmers, backers, corners, cripples, sills, beam pockets.

Framer-Friendly Tips

To improve wall alignment quality or when using tall studs, crown each stud.

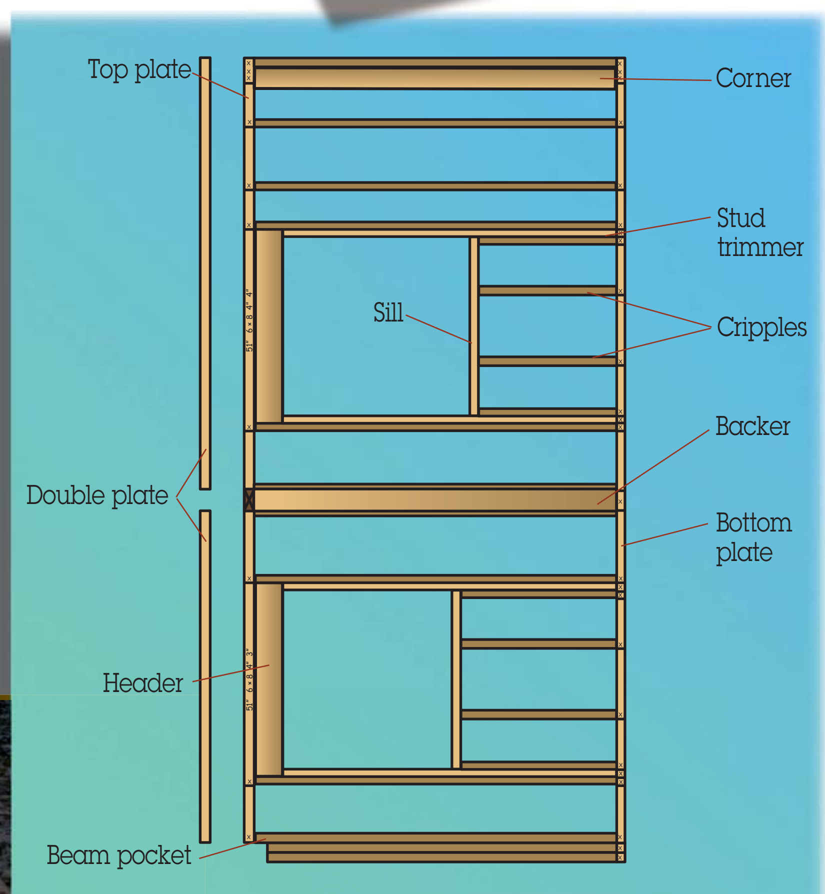
Steps 3–7–Assemble Wall

3: Spread studs
4: Nail headers to studs
5: Nail top plate to studs & headers
6: Nail bottom plate to studs
7: Nail double plate to studs

Framer-Friendly Tips

Check your window opening sizes once everything is nailed.

Following the nailing patterns discussed in Chapter 2, the wall frame components can now be assembled. Pneumatic nailers reduce the amount of time required to perform this task.



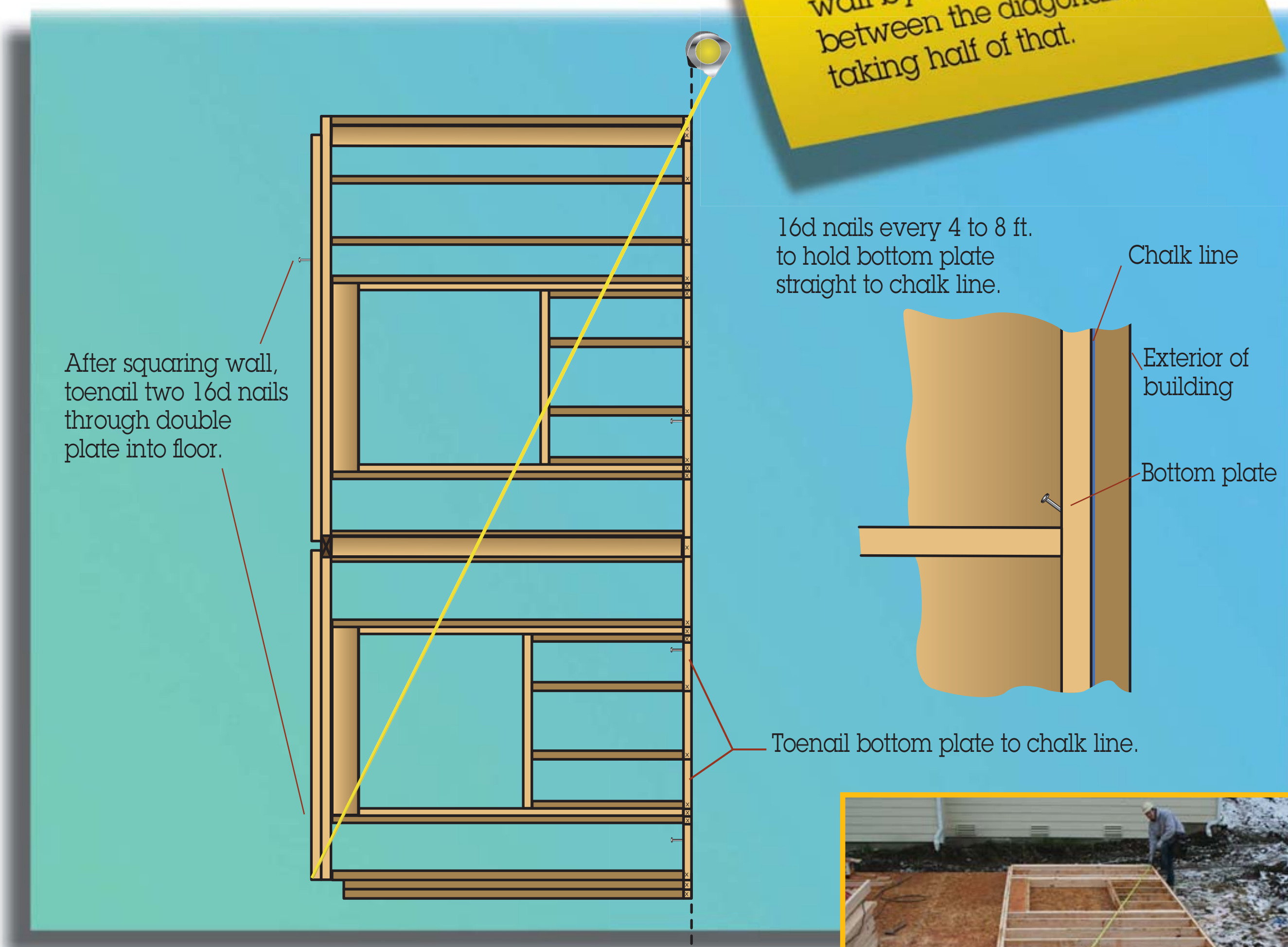
Spread remaining wall parts and nail.

Step 8–Square Wall

Exterior Wall

Framer-Friendly Tips

You can quickly figure how much you need to move the wall by finding the difference between the diagonals and taking half of that.



To square a wall, secure the bottom plate as shown, then move the top of the wall until the diagonal dimensions are equal. Once the wall is square, secure it with two nails through the double plate into the floor.

Nail on the inside of the bottom plate so the nails will hold the wall in position while it is being stood. The bottom plate should be nailed so that it's in line with the wall chalk line. Then, when the wall is raised, it will be in the right position.

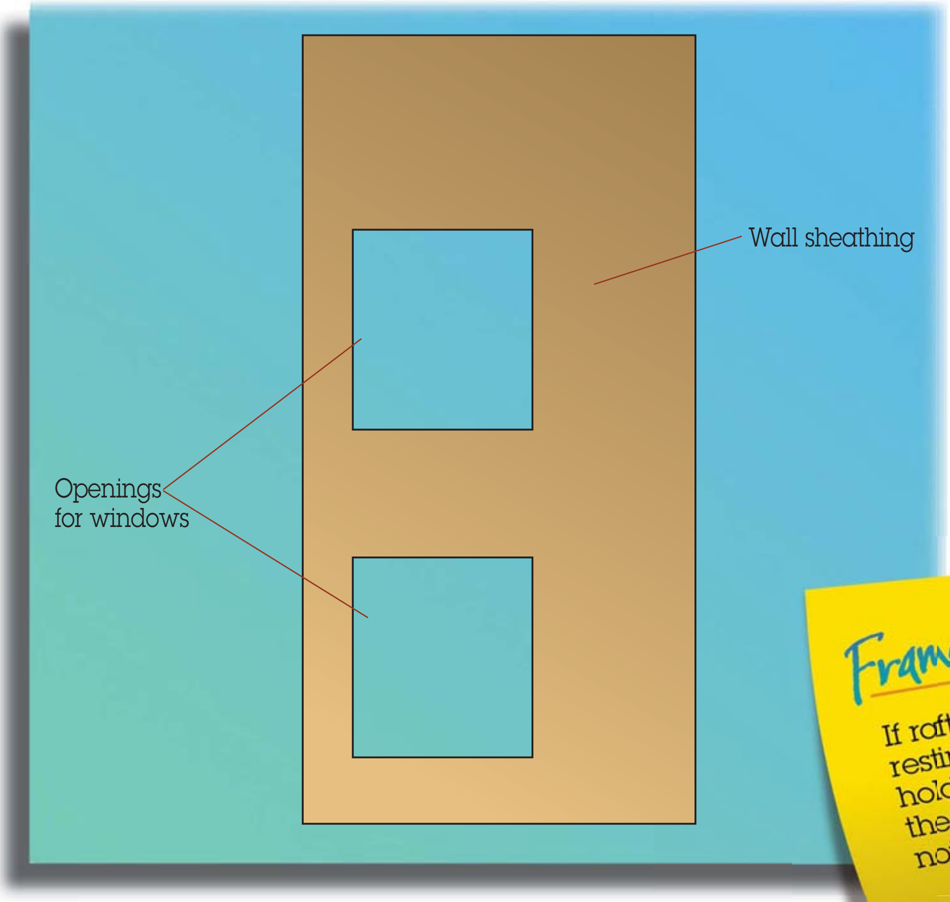
Step 9–Sheathe Wall

Sheathing: place, cut openings, and nail.

Cover the entire wall with sheathing, then rout window and door openings with a panel pilot router bit (see illustration). Save the leftover pieces of sheathing for small areas and filling in between floors.

If the first floor exterior walls can be reached from the ground, then the sheathing is not installed until after the walls are plumb and lined (straight and true; see Step 16-Plumb & Line). This eliminates the potential problem of a square wall sitting on a foundation that is not level.

Panel pilot router bit



Framer-Friendly Tips

If rafters or roof trusses will be resting on the corner of the wall, hold the sheathing down from the top – enough so that it will not interfere with the rafters.

Step 10–Install Nail-Flange Windows

Before Wall is Stood Up

a. Check plans for correct window.

b. Check window opening for protrusions (nails, wood splinters, etc.) that might hold window away from edge.

c. Install window flashing. (See “Window Flashing Installation,” Chapter 6.)

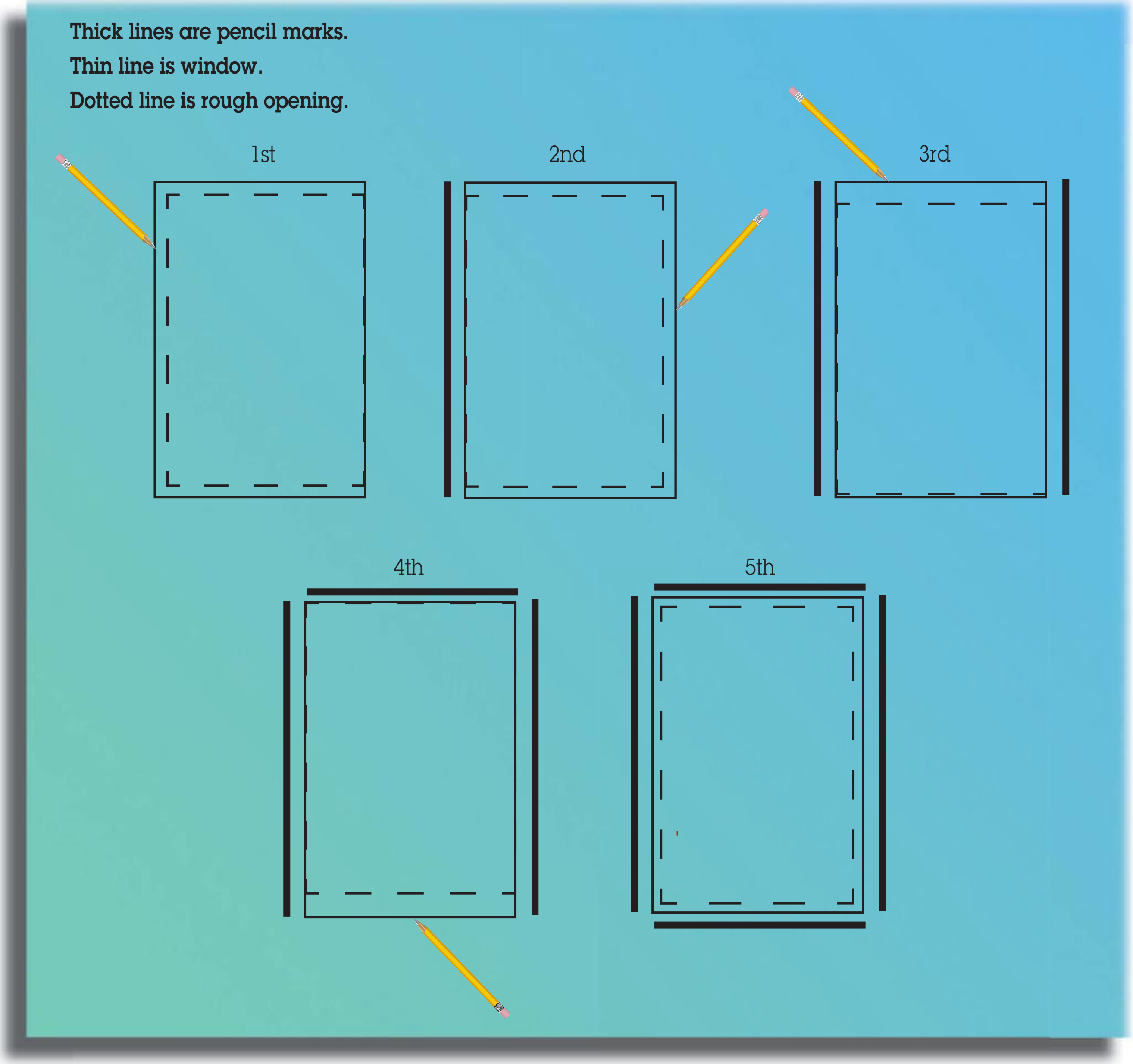
d. Set window in opening, making sure window is right side up.

e. Slide window to each end of opening, and draw a line on the sheathing or flashing with a pencil along the edge of window. (Draw lines before caulking window.)

f. Center window in marks you have just drawn.

g. Nail window sides and bottoms, using appropriate nails.

h. Do not nail top of window.



Steps 11–15–Standing & Setting Wall

11: Stand wall.
12: Set bottom plate.
13: Set double plate.
14: Set reveal.
15: Nail wall.

Corner securing two walls

Framer-Friendly Tips

Before standing a wall, check underneath for miscellaneous debris, such as loose nails.

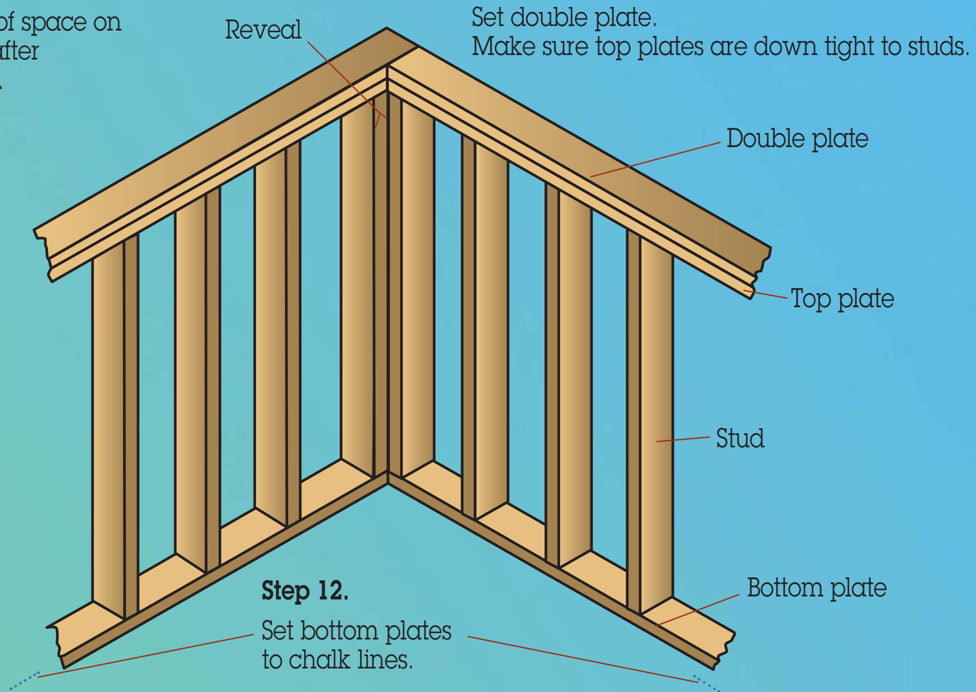
Step 14.

Nail the end stud to set the reveal* in the middle of the wall where the two walls join. The reveal in the middle of the wall should be the same as the top and bottom reveal.

* The reveal is the amount of space on the corner stud of a wall after another wall is joined to it.

Step 13.

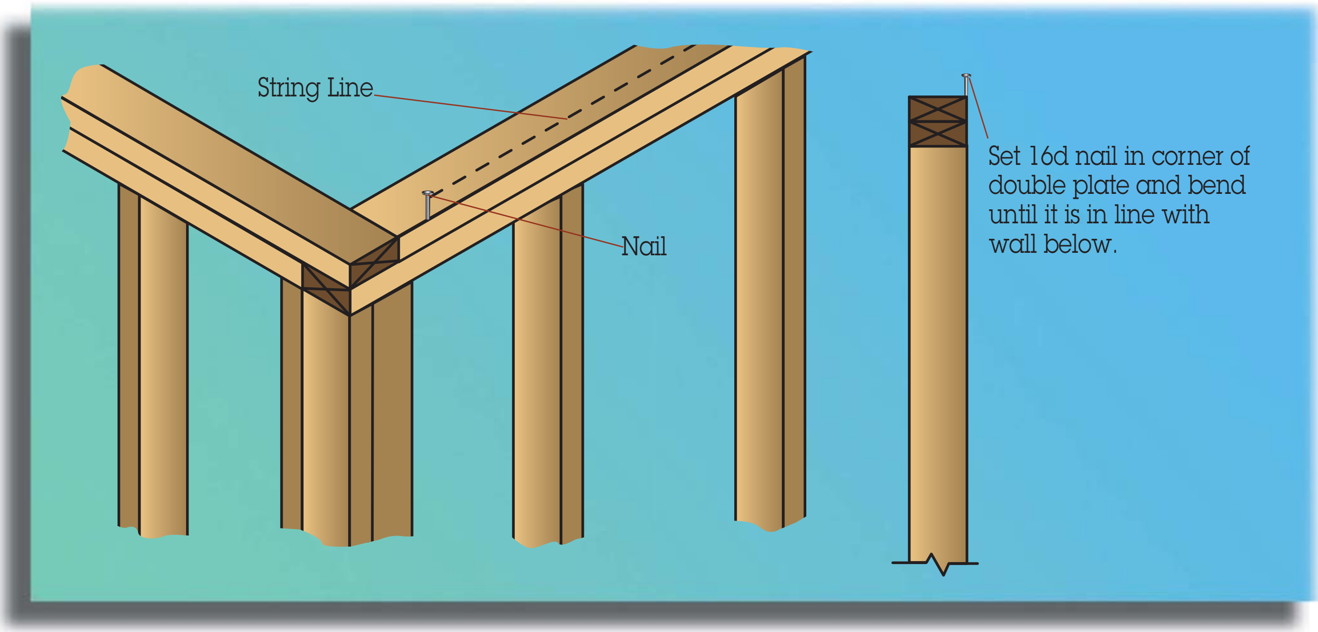
Set double plate.
Make sure top plates are down tight to studs.



Step 15.

Nail walls together, and nail bottom plate.

Step 16–Plumb & Line



"Plumb and line" is the process of making the walls straight and true.

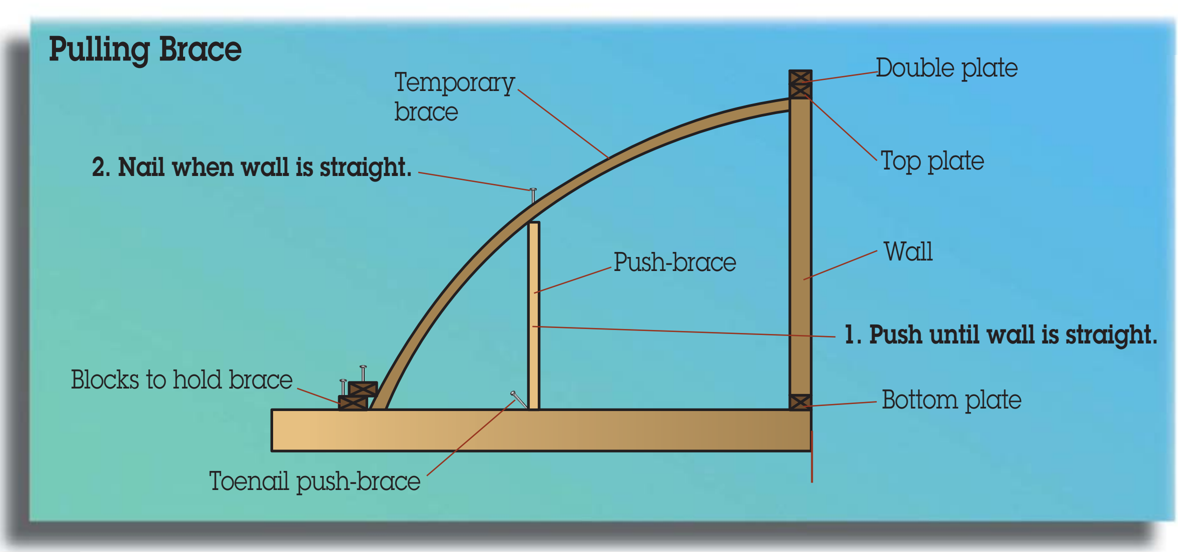
"Plumbing" is the use of a level to set the ends of the walls plumb or perfectly upright.

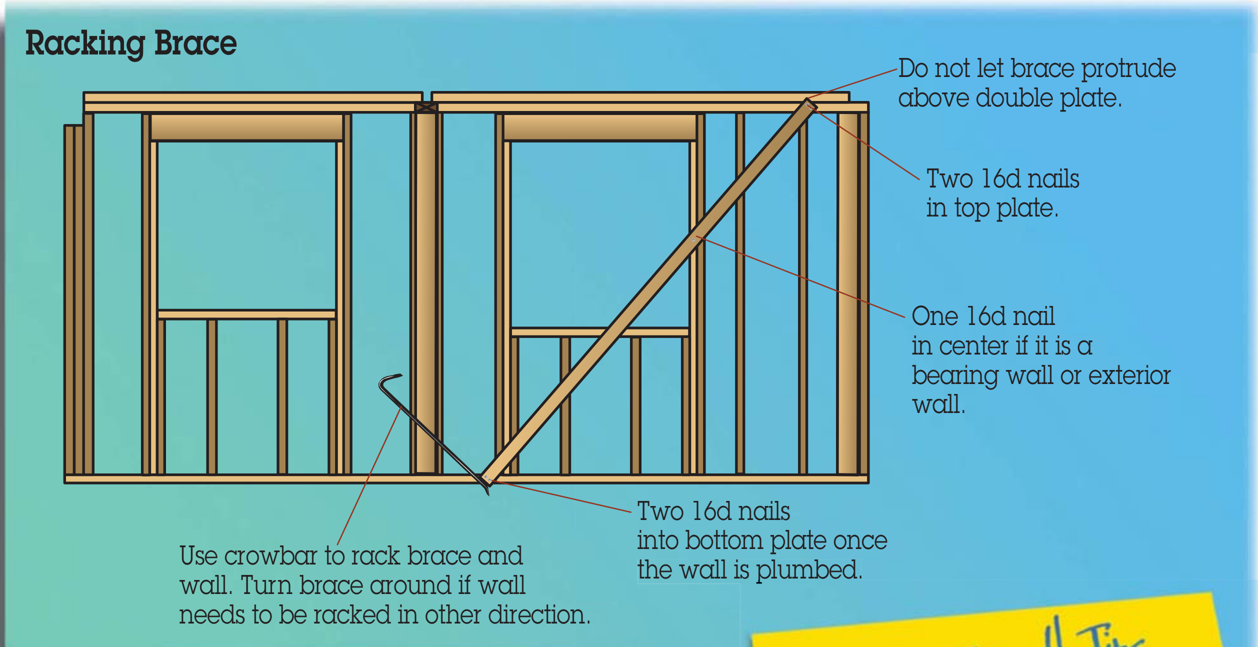
"Lining" is using a tight string attached to the top of a wall as a guide for straightening it.

Set nails at either end of wall as shown, and then string line tightly between them, adjusting the line so that it is about ½" above the double plate. Wall should be moved in or out to align with string.

The walls are braced with 2 × 4 lumber to hold them and, if necessary, make them plumb and straight.

If a wall already is sheathed and in place, but not plumb, correct it if it is more than ¼" out of plumb for standard height walls.





Racking a wall is moving the top of the wall with the bottom secure until the wall is plumb.

Framer-Friendly Tips

For best results, your level should be long enough to reach from bottom plate to top plate.

One framer racks the wall with a brace and crowbar, while the second framer checks for plumb.

Plumbing Tools

A level is the traditional tool for determining plumb. A laser can also be used. Whichever tool you use, you want to make sure you check it for true before you start. To check a level, hold it in position against a wall and read the bubble. Then turn it around and place it in the same position against the wall. If the bubble reads the same, then your level is accurate. To check a laser use a similar method. Set it in place, and mark the bottom dot and the top dot. Then turn it around and align the bottom dot. If the top dot hits the same spot on the top of the wall that you marked, your laser is reading accurately.

Levels are accurate when the level is long enough to reach from the bottom plate to the top plate. An 8' level will work fine for most residential walls. A 12' extension level works for walls up to 12'. If the level does not reach from plate to plate, you have to figure that there will be some variance for the studs' irregularities.

Lasers are good for taller walls. Lasers are not dependent on perfect wood for determining plumb. Set the laser at the bottom, and read the distance you set at the bottom on your tap at the top of the wall. If you need to check plumb on a regular basis, the laser has the advantage of fitting in your pouch.

Plumbing tall wall with extending level.

Framing Rake Walls

There are four common ways to figure stud heights and build rake walls.

1. Chalk lines on the floor.
2. Figure lengths on paper.
3. Build and chalk lines.
4. Stick frame.

Each has its own advantages. With all these methods, you must use the pitch given in the plans to determine the wall height. The pitch is generally shown on the elevation sheet just above the roof slope.

Method 1: Chalk Lines on the Floor

The first method is to chalk out a duplicate on the floor, if you have the space. Then you can measure and cut the studs and plates right from your chalk lines.

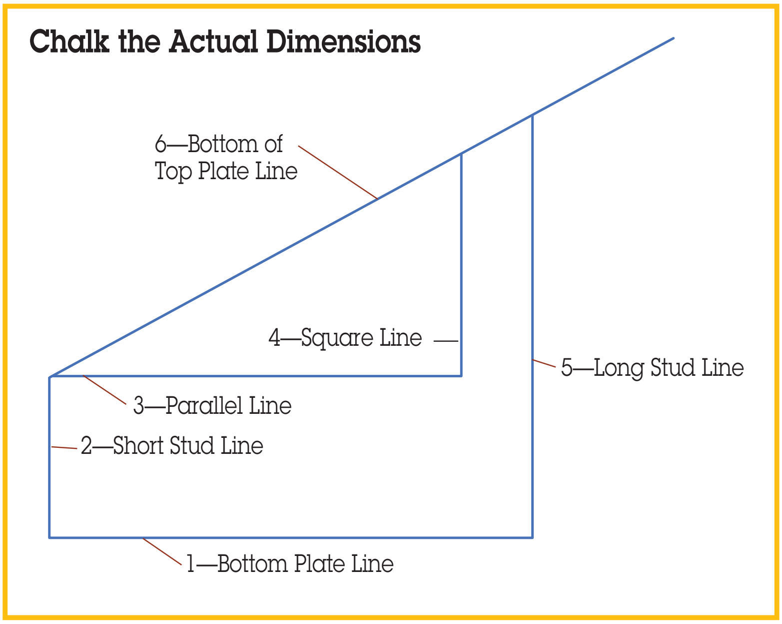
The advantage to using this method is that it is quick, easy, accurate, and doesn't require a lot of math. However, if you don't have the space on the floor, if it's raining and you can't chalk lines, or you have a lot of rake walls in the building, it is probably best to use one of the other methods suggested.

To chalk the lines, you need to know the heights of your low point and high point. You must also ensure that the wall is square. To find the height, you can use the "Chalk the Actual Dimensions" system. The pitch on the plans gives you the relationship of the rise to the run. For example, a 6:12 pitch means that for every 12 units of run, there are 6 units of rise. To find the high point on the wall, go out 12 units of run, then up square 6 units. Mark this reference point and chalk a line from the low point of the wall through this point, and extend it as far as necesary to reach the high point in the wall. The closer you make the reference point to the high point in the wall, the more accurate your line will be.

To find the rake wall stud heights using the "Chalk the Actual Dimensions" method, follow these steps:

1. Chalk a bottom plate line (1). Usually you can use the chalk line for your wall. (See "Chalk the Actual Dimensions" illustration.)
2. Chalk the short stud line (2). Make sure it's square (perpendicular) with the bottom plate line (1). You can use the 3-4-5 triangle to square the line. (Explained in "To Square the Wall" and "3-4-5 Triangle" later in this chapter.)
3. Chalk a parallel line (3) with the bottom plate line (1) that aligns with the top of the short stud. Extend this line out toward the long stud (5).

An unsheathed rake wall



A 3-4-5 triangle will help you establish that two lines are square or at right angles to each other. To establish square, just follow these steps:

1. Start with the line you want to square from; this will be the 4-unit line—also referred to as the run.
2. Measure a line perpendicular to the run line at 3 units in length, called the rise.
3. Measure the diagonal from the outside of the 4-unit line (run) and the 3-unit line (rise), and adjust the 3-unit line so that the diagonal (hypotenuse) is exactly 5 units.

The units can be anything as long as they are in the same ratio. For example, they could be 3', 4', and 5', or they could be 15', 20', and 25'. The longer the units, the more accurate your measurement will be.

4. Chalk a square line (4) to the parallel line that is close to the long stud line (5), but convenient for figuring its length. The length of the square line (4) will be in a relationship to the parallel line (3), depending on the pitch of the rake wall. If, for example, the pitch is 6/12 and the parallel line is 12, the square line will be 6.
5. Chalk a line square (4) with the bottom plate line (1) where the long stud line (5) should be.
6. Chalk a line from the short point of the short stud (2) through the top of the square line (4) and on past the long stud line (5). This will be your bottom of top plate line (6).
7. Once you have these lines, you will be able to fill in all the remaining studs.

To Square the Wall:

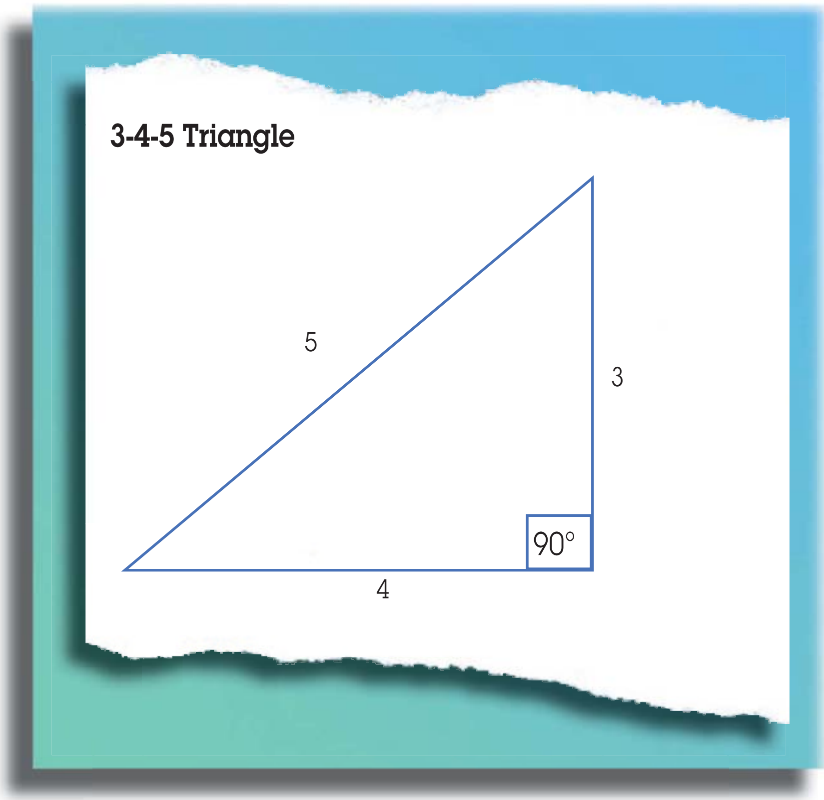
- Draw a straight line where you want to place your bottom plate, then make a perpendicular line at the high point of your wall.
- Use a 3-4-5 triangle to double-check that the line is exactly perpendicular or square. (See "3-4-5 Triangle" illustration.)

Method 2: Figure Lengths on Paper

With this method, you figure the stud heights, plate lengths, and layout anywhere you want—whether in the office, at home, or on the job site. All you need is a set of plans. Once you have the heights and lengths figured, you can build the wall anywhere, then move it into position.

Use the "Rake Wall Stud Heights" worksheet later in this chapter to figure the stud heights, the plate lengths, and the layout points. Give the completed worksheet with all needed information to whoever is framing the wall.

A construction calculator, such as Construction Master IV®, can be used to figure lengths accurately. With a construction calculator, you can work in feet and inches and use a memory function for repetitive calculations.



To use the Rake Wall Stud Heights Worksheet, just fill in the blanks and find the stud heights. The column "D" is where you write the distance on the bottom plate from the start of the rake wall to the short point on the stud. There is less confusion if you always use the short point on the studs. It is also easier to cut the short point than the long point when using a worm drive saw.

The stud height to the short point is found by using the formula (D × RP) + BH. RP is the rise percent, or the relationship between the rise and the run. The relationship gives you the height increase of the studs per increase in the distance of the plate. This relationship is illustrated in the filled-in version of the Rake Wall Stud Heights Worksheet. The formula for finding RP is also shown, in the "Rise & Diagonal Percent" illustration later in this chapter.

The "Rake Wall, RP, DP, Saw Angle" illustration provides the rise percent for common roof pitches. The "BH" from the formula is the beginning stud height. BH is a constant and is the height of the first stud at the lowest point. This height can vary depending on how the rafter or lookouts rest on the rake wall.

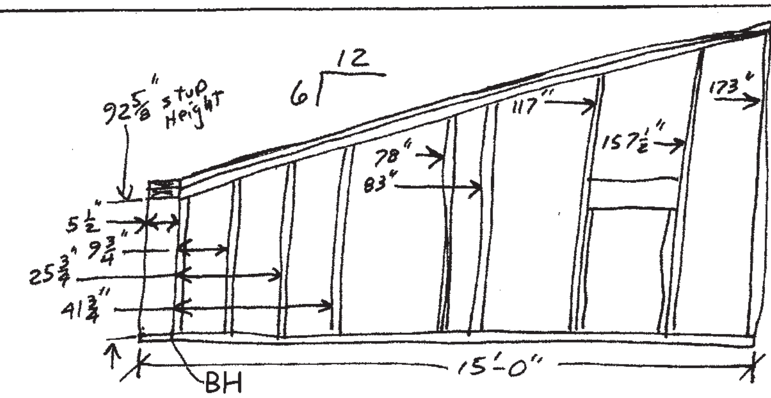
A typical beginning height would be slightly lower than the adjoining wall, as shown in the "Rake Wall Beginning Stud Height" drawing. In this example, the beginning stud height is only 3/8" less than the adjoining wall stud height because the plates on the rake are thicker on a slope than they are when flat.

To find the layout points for the studs and the length of the plates, use the formula D × DP. DP is the diagonal percent, or the relationship between the Diagonal and the Run. This relationship tells you the length increase of the top plate or layout point per increase in the distance of the bottom plate. This relationship is shown in the "Rise & Diagonal Percent" illustration, which also provides the formula for finding DP. The drawing gives the Diagonal Percents for the common roof pitches and the saw angles—the different angles at which you can set your saw to cut the top of the studs and the ends of the top plate and double plate.

Framer-Friendly Tips

This method takes the most time to learn and set up, but once you master it, you'll probably use it exclusively.

Rake Wall Stud Heights—Example



D = Distance from start of rake wall	Wall location North bedroom
H = Height of stud to short point	(RP)-Rise Percent = .5
L = Layout point for studs to short point	Wall Type = 2 X 6 - SW2
BH = Beginning stud Height = 92 1/4	Length of top plate long to short = 195 1/16
(DP)-Diagonal Percent = 1.118	Roof pitch = 6/12 Angle for saw = 26 1/2°

		H = (D x RP)+ BH	L = D x DP				H = (D x RP)+ BH	L = D x DP	
Stud #	**D**	**H**	**L**	I	**Stud #**	**D**	**H**	**L**	
1	0	92 1/4	0	I	24				
2	9 3/4	97 1/8	10 7/8	I	25				
3	25 3/4	105 1/8	20 13/16	I	26				
4	41 3/4	113 1/8	46 11/16	I	27				
5	57 3/4	121 1/8	64 9/16	I	28				
6	73 3/4	129 1/8	82 7/16	I	29				
7 B	78	131 1/4	87 3/16	I	30				
8 B	83	133 3/4	92 13/16	I	31				
9	89 3/4	136 3/4	100 5/16	I	32				
I 10	105 3/4	145 1/8	118 1/4	I	33				
K 11 S	117	150 3/4	130 13/16	I	34				
K 12 S	157 1/2	171	176 1/16	I	35				
13	169 3/4	177 1/8	189 3/4	I	36				
14 E	173	178 3/4	193 7/16	I	37				
15				I	38				
16				I	39				
17				I	40				
TOP 18 PL	174 1/2		195 1/16	I	41				
19				I	42				
20				I	43				
21				I	44				
22				I	45				
23				I	46				

B = Backer

KS = King Stud

Top PL = Top Plate

Method 3: Build and Chalk Lines

This method is possibly the quickest way to figure stud heights and build rake walls. Here is how it is done:

- First, lay out the bottom plate in the same way you would if you were going to frame an ordinary wall.
- Spread your studs, making sure that they are long enough to reach the top of the rake wall.
- Toenail the bottom plate from the inside of the plate so that when the wall is lifted, the nail will function as a pivot point on the layout line.
- Cut the length of the beginning stud to match the adjoining wall. Take into consideration the location of the rafters if the lookouts rest on the rake wall, and the thickness of the plates on the rake.
- Set the beginning stud square with the bottom plate.
- Use the rise percent to find the length of the longest stud. (See the "Rake Wall, RP, DP, Saw Angle" illustration.)
- Set that stud square with the bottom plate.
- Nail the rest of the studs to the bottom plate.
- Block the wall where required.
- Position all the studs so they are square.
- Chalk a line along the top of the studs.
- Cut each stud.
- Measure and cut the top plate and double plate.
- Nail the top plate to the studs, and the double plate to the top plate.

Method 4: Stick Frame

With this method, you are framing the wall in place.

- Find the beginning stud and the longest stud heights in the same way you would with the other methods.
- Nail the bottom plates to the floor, and brace the beginning stud and the longest studs in place.
- Make sure that the studs are plumb before continuing.
- Measure, cut, and nail the top plate onto the studs.
- Lay out the top plate using the "Figure Lengths on Paper" method, or plumb up from the bottom plate. Measure, cut, and nail the remaining studs in place.

Framer-Friendly Tips

For tall walls that require blocking, if you nail the blocking as you go, the studs will be held in place so you can nail the top plates on all at one time.

Rake Wall Stud Heights Worksheet

D = Distance from start of rake wall	Wall location ________
H = Height of stud to short point	(RP)-Rise Percent = ________
L = Layout point for studs to short point	Wall Type = ________
BH = Beginning stud Height = ________	Length of top plate long to short = ________

(DP)-Diagonal Percent = ________ Roof pitch = ________ Angle for saw = ________

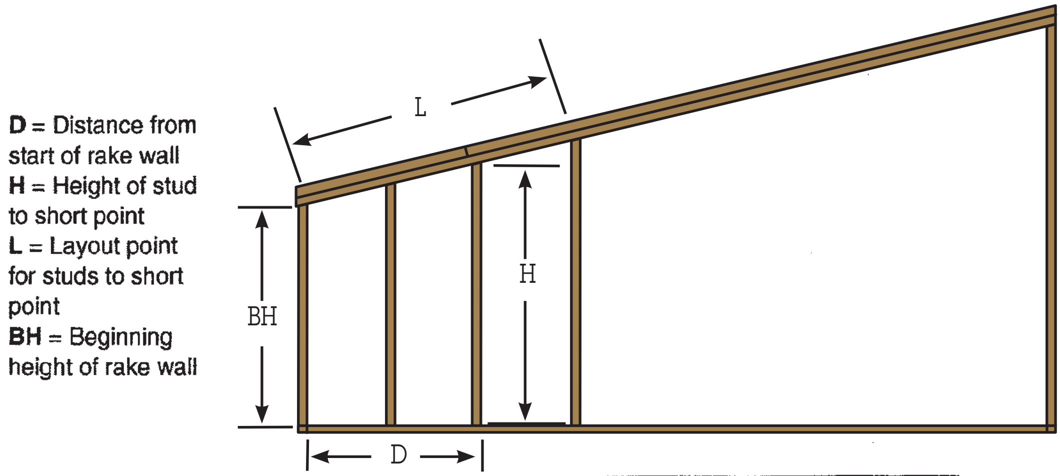
		H = (D x RP)+ BH	L = D x DP				H = (D x RP)+ BH	L = D x DP	
Stud #	**D**	**H**	**L**		**Stud #**	**D**	**H**	**L**	
1					24				
2					25				
3					26				
4					27				
5					28				
6					29				
7					30				
8					31				
9					32				
10					33				
11					34				
12					35				
13					36				
14					37				
15					38				
16					39				
17					40				
18					41				
19					42				
20					43				
21					44				
22					45				
23					46				

B = Backer

KS = King Stud

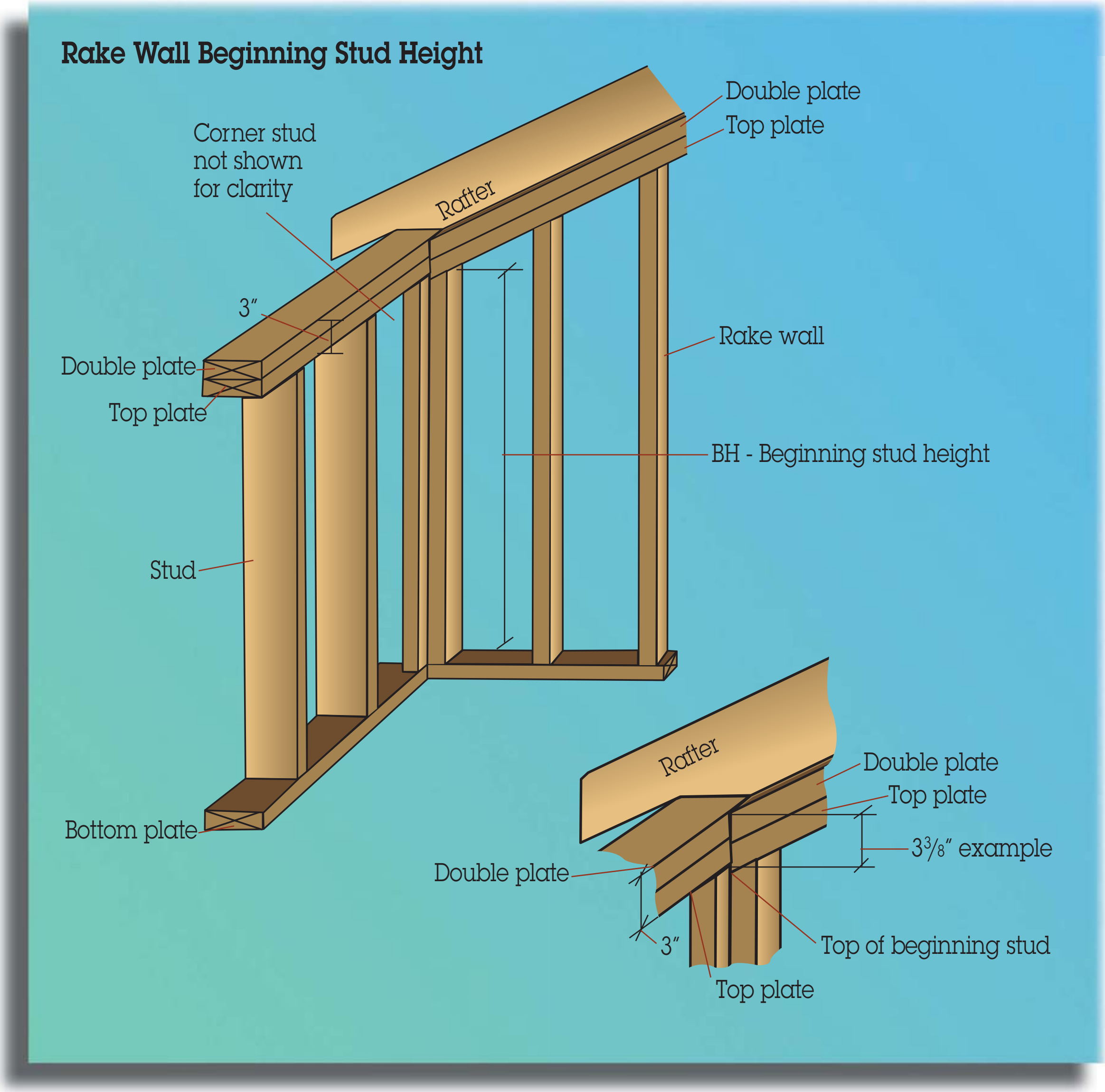
Top PL = Top Plate

Rake Wall RP, DP, Saw Angle



H = (D x RP) + BH   **L = D x DP**

PITCH	RP-Rise Percent	DP-Diagonal Percent	SAW ANGLE
1/12	0.08	1.00	4.50
2/12	0.17	1.01	9.50
3/12	0.25	1.03	14.00
4/12	0.33	1.05	18.50
5/12	0.42	1.08	22.50
6/12	0.50	1.12	26.50
7/12	0.58	1.16	30.25
8/12	0.67	1.20	33.75
9/12	0.75	1.25	37.00
10/12	0.83	1.30	40.00
11/12	0.92	1.36	42.50
12/12	1.00	1.41	45.00

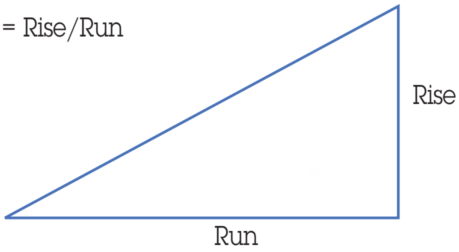


Please note that the beginning stud height on a rake wall is not the same as a typical stud.

Rise & Diagonal Percent

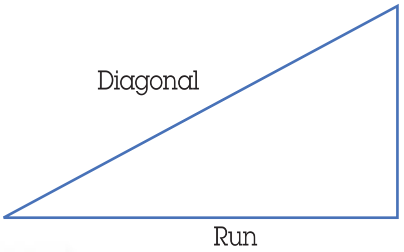
Rise Percent

RP = Rise Percent = Rise divided by Run = Rise/Run



Diagonal Percent

DP = Diagonal Percent = Diagonal divided by Run = Diagonal/Run



Standing a rake wall

Chapter Five
ROOF FRAMING

Contents

Roof Framing Terms 72
Step 1–Finding the Lengths of Common Rafters 74
Step 2–Cut Common Rafter 83
Step 3–Set Ridge Board 86
Step 4–Set Common Rafters 87
Step 5–Find Length of Hip & Valley Rafters 88
Step 6–Cut Hip & Valley Rafters 89
Step 7–Set Hip & Valley Rafters 91
Step 8–Set Jack Rafters 92
Step 9–Block Rafters & Lookouts 93
Step 10–Set Fascia 93
Step 11–Install Sheathing 94
Rafter Guidelines 95
Ceiling Joists 106
Step 1–Spread Trusses 108
Step 2–Sheathe Gable Ends 109
Step 3–Set Gable Ends 109
Step 4–Roll Trusses 110
Steps 5–8 111

Chapter Five

ROOF FRAMING

Framing a roof is the most difficult aspect of framing, and the ability to construct a roof is a real test of your framing skills. This chapter has three separate sections. The first addresses basic rafter framing, including roof framing terms, roof styles, five methods of finding rafter lengths, the eleven steps for framing a roof with rafters, and ceiling joist information.

The second section of the chapter covers finding rafter lengths using the “Diagonal Percent” method. You can follow an example to learn how to cut difficult rafters. If you master this system, you will be able to “cut and stack” a roof, which means you can cut all the rafters and stack them ready for installation before the first one is installed. If you are familiar with the basics of rafter cutting, you might want to skip to this section. Some of the basic steps are duplicated for the example. The final section of the chapter discusses the eight steps of roof truss framing.

Roof trusses are typically pre-manufactured off site and delivered to the job site. They are engineered for strength and use standard dimension lumber. Gang nail plates are used to connect the cords and struts that make up the trusses.

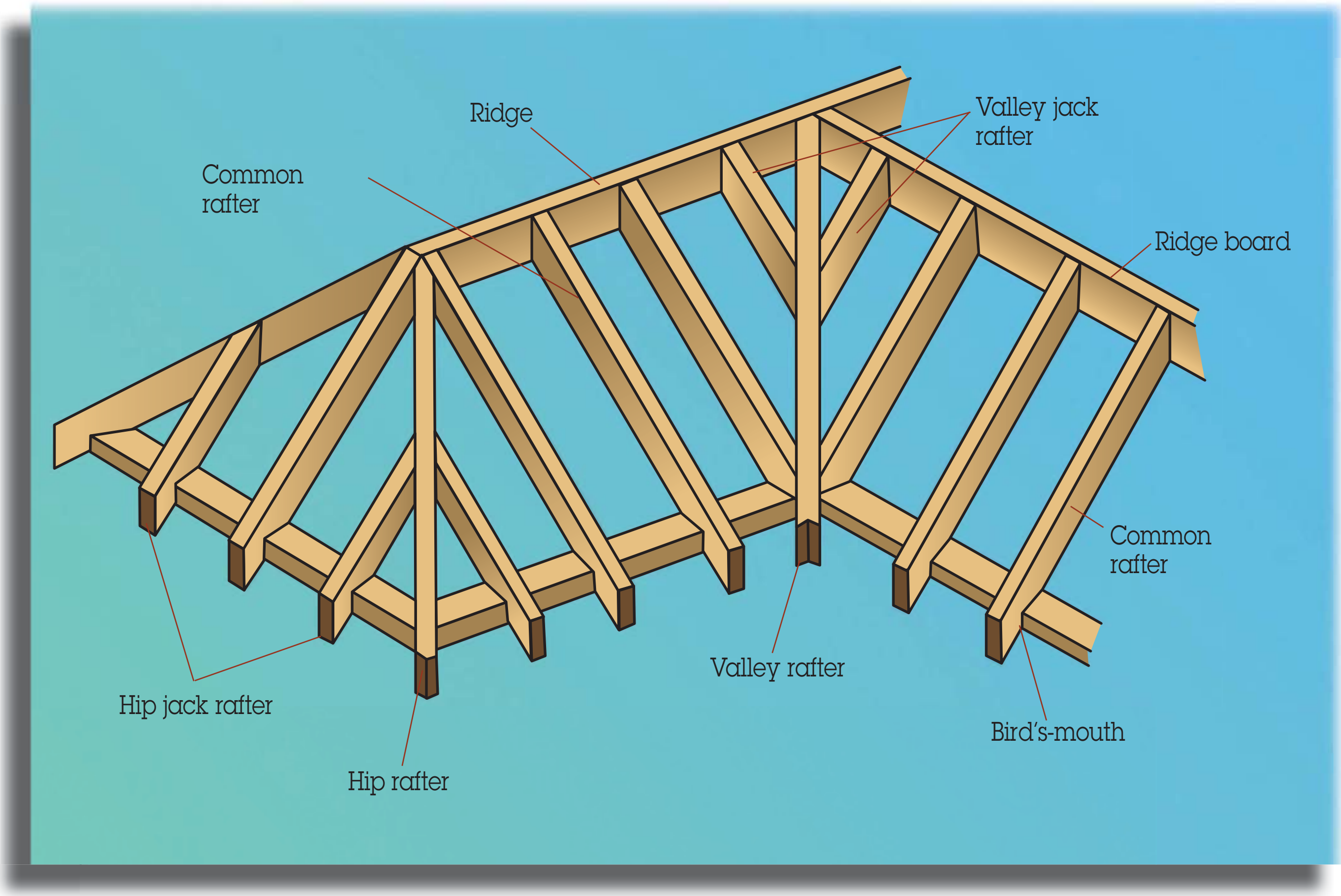
The angles and pitches of a roof are as varied as the colors in a child’s crayon box. Just as some colors have certain characteristics in common, so do rafters and trusses. This chapter is organized around these common characteristics. Key steps for framing a roof with rafters and trusses are provided.

The most difficult part of framing a roof is finding the rafter length. It is based on the relationship between the rise (vertical) distance and the run (horizontal) distance. In this chapter, you’ll find methods for finding the rafter length, though you ultimately will only need to memorize the approach you’re most comfortable with. You will also find that at different times you might want to use different methods.

Prefabricated trusses, factory-made from the architect’s specifications, require, of course, no calculations on your part. Uniform in size, they are somewhat easier to work with than ridgeboards and rafters. Still, they are heavy to work with, especially working at heights.

This chapter starts with important rafter terms, followed by steps for calculating and cutting rafters and installing sheathing. The second half of the chapter provides more detailed information and examples on finding rafter length. The chapter ends with a discussion of joists and trusses.

Roof Framing Terms



Important Rafter Terms

Span—the distance between two supporting members, typically measured from the outside of two bearing walls.

Run—horizontal distance.

Rise—vertical distance.

Diagonal—the distance between the far point on the run and the high point on the rise. (Similar to hypotenuse in mathematical terms.)

Hip or valley run—the horizontal distance below the hip or valley of a roof, from the outside corner of the wall to the center framing point.

Overhang hip run—the horizontal distance below the overhang hip of the roof, from the outside corner of the wall to the outside corner of the fascia.

Hip or valley diagonal—the distance between the far point on the hip or valley run and the high point on the hip or valley rise.

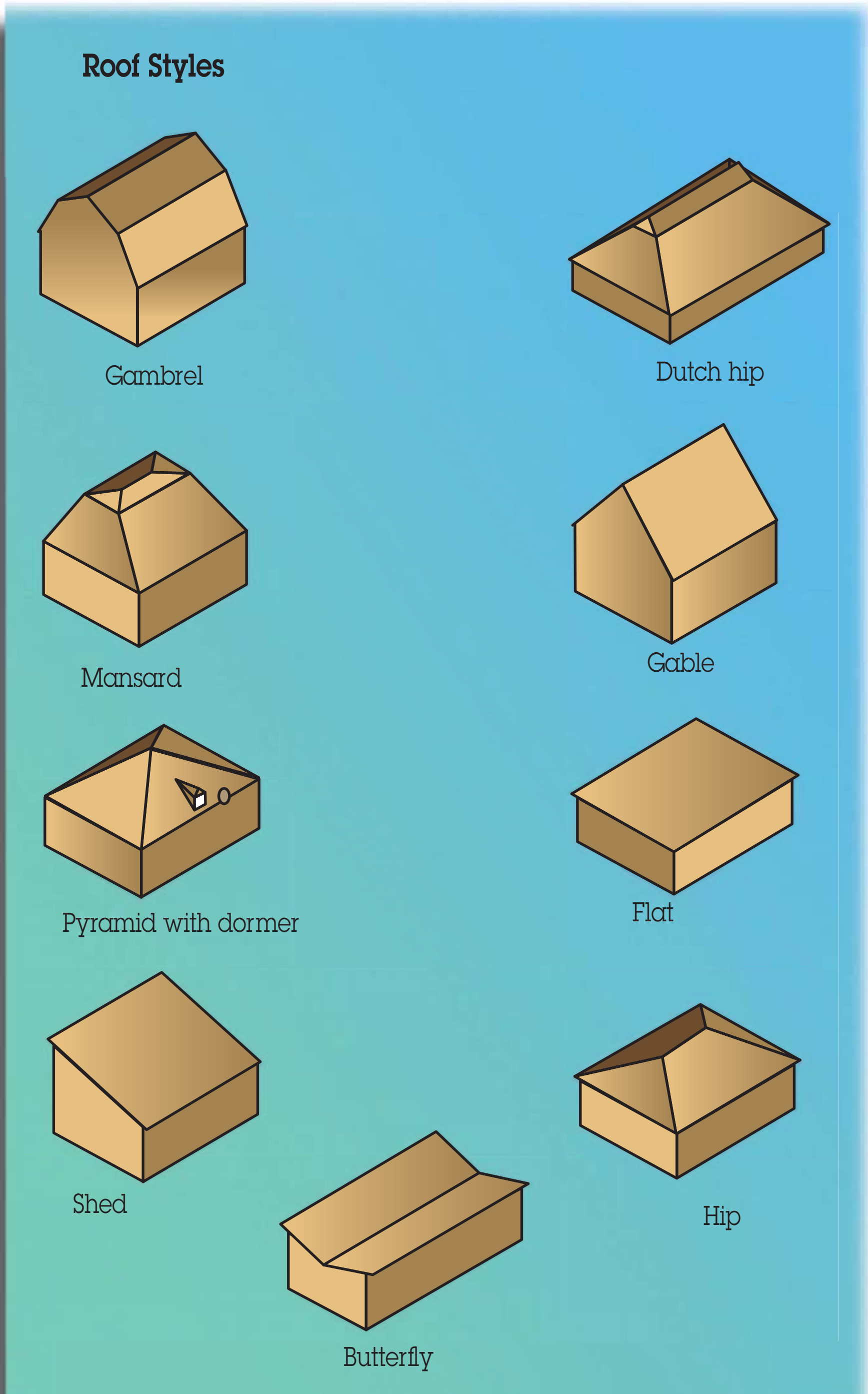
Overhang diagonal—the distance between the far point on the overhang run and the high point on the overhang rise.

Diagonal percent—the diagonal divided by the run.

Hip-val diagonal percent—the hip or valley diagonal divided by the hip or valley run.

Rise percent—the rise divided by the run.

Pitch—the slope of the roof, or the relationship of the run to the rise. Typically defined as a certain height of rise for 12 units of run for a common rafter, and 17 (16.97) units of run on a 90° hip or valley rafter.



Framing point—the point where the center lines of connecting rafters, ridges, hips, or valleys would meet.

Cheek cut—an angle cut that is made to bear against another rafter, hip, or valley.

Common rafter—a rafter running from a wall straight to a ridge board.

Jack rafter—a rafter running to a hip rafter or a valley rafter.

Hip rafter—a rafter at an outside corner of a roof that runs in between and joins jack rafters that bear on corner walls.

Valley rafter—a rafter at an inside corner of a roof that runs between and joins with jack rafters from each side.

Ridge end rafter—a rafter that runs from the end of a ridge.

Pitch angle—the vertical angle on the end of a rafter that represents the pitch of the roof.

Connection angle—the horizontal angle at the end of a rafter needed to connect to other rafters, hips, valleys, or ridge boards.

Important Considerations for Cutting Rafters

When cutting rafters, you need to consider the following four factors:

1. The length: determined by two factors—distance spanned and slope.
2. The adjustment to the length at the top and bottom. The top and bottom adjustments can depend on a number of factors and are almost always a little different. The two main factors are the distance from the true ridge or framing point, and the connection with other framing members.
3. The angle of cuts at the top, bottom, and the bird's mouth. The angle cuts relate to the pitch of the roof and the position of the framing member the rafters are attaching to.
4. The height at the bird's mouth. The height of the bird's mouth can be set by details on the plans, for bearing, or to keep the roof level at the plate height.

There are many different ways to cut and set rafters. It doesn't matter which method is used as long as the completed roof is structurally sound and looks the way it was intended. Different approaches work best on different types of roofs. Sometimes a combination of methods works best.

This chapter will not discuss the specifics of all the different rafter cutting methods, but will instead describe what is possibly the easiest way for figuring the information needed to cut rafters. Using this method, you will be able to "cut and stack" a roof. That is to say, you will be able to cut all the rafters on the ground and stack them ready for installation before the first one is installed.

Step 1–Find the Lengths of Common Rafters

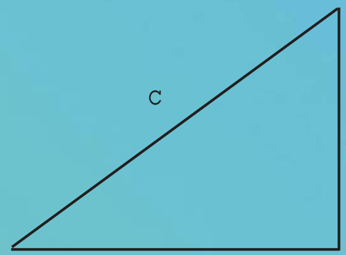
There are six methods for finding common rafter lengths. Study them all and use the one that works best for you.

They are:

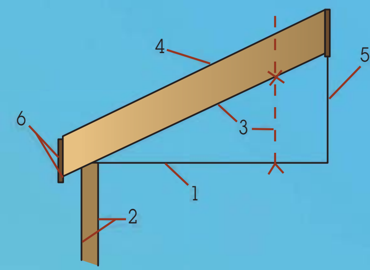
A. The Pythagorean Theorem
B. Framing Square Rafter Method
C. Framing Square Stepping Method
D. Chalking Lines Duplication Method
E. Computer Software Method
F. Diagonal Percent Method

Methods for Finding Common Rafters

A. Pythagorean Theorem

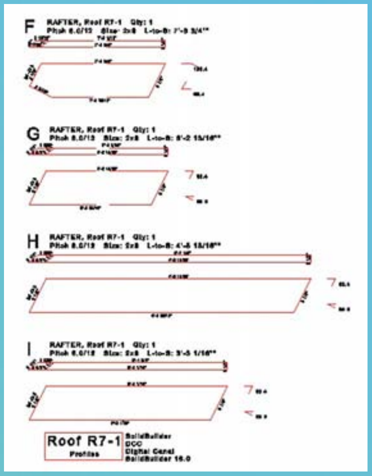


D. Chalking Lines Duplication Method

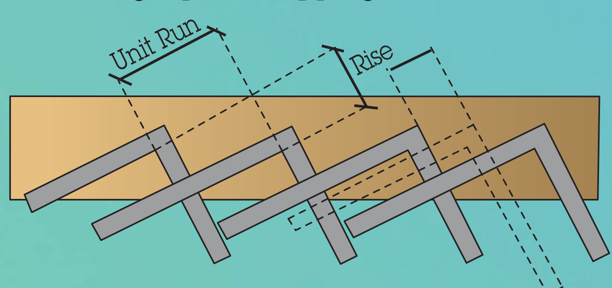


B. Framing Square Rafter Method

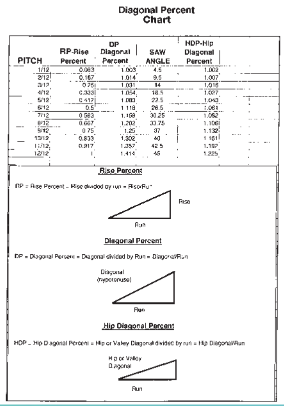
E. Computer Software Method



C. Framing-Square Stepping Method



F. Diagonal Percent Method



Diagonal Percent Chart

PITCH	RP-Rise Percent	DP Diagonal Percent	SAW ANGLE	HDP-Hip Diagonal Percent
1/12	0.083	1.003	4.5	1.002
2/12	0.167	1.014	9.5	1.007
3/12	0.25	1.031	14	1.016
4/12	0.333	1.054	18.5	1.027
5/12	0.417	1.083	22.5	1.043
6/12	0.5	1.118	26.5	1.061
7/12	0.583	1.158	30.25	1.082
8/12	0.667	1.202	33.75	1.106
9/12	0.75	1.25	37	1.132
10/12	0.833	1.302	40	1.161
11/12	0.917	1.357	42.5	1.192
12/12	1	1.414	45	1.225

Rise Percent

RP = Rise Percent = Rise divided by run = Rise/Run

Diagonal Percent

DP = Diagonal Percent = Diagonal divided by Run = Diagonal/Run

Hip Diagonal Percent

HDP = Hip Diagonal Percent = Hip or Valley Diagonal divided by run = Hip Diagonal/Run

A. Pythagorean Theorem

Pythagoras was an ancient Greek philosopher and mathematician. His famous theorem states that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the two other sides.

Thus: $A^2 + B^2 = C^2$

In roof framing:

A = the Rise

B = the Run

C (the hypotenuse) = the Rafter Length.

Run = ½ building width – ½ ridge board width

H = is given on plans = the amount of rise per foot of run

Rafter Cut Length = Rafter Length + Rafter Tail Length

Finding Rafter Length

First, find the run by using this formula:

Run = ½ building width – ½ ridge board width

Second, find the rise by using this formula:

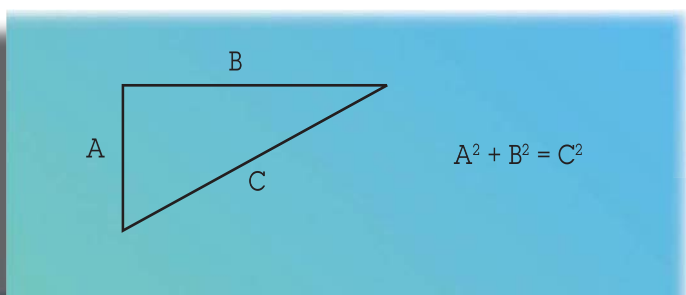
Rise = H/12 × Run

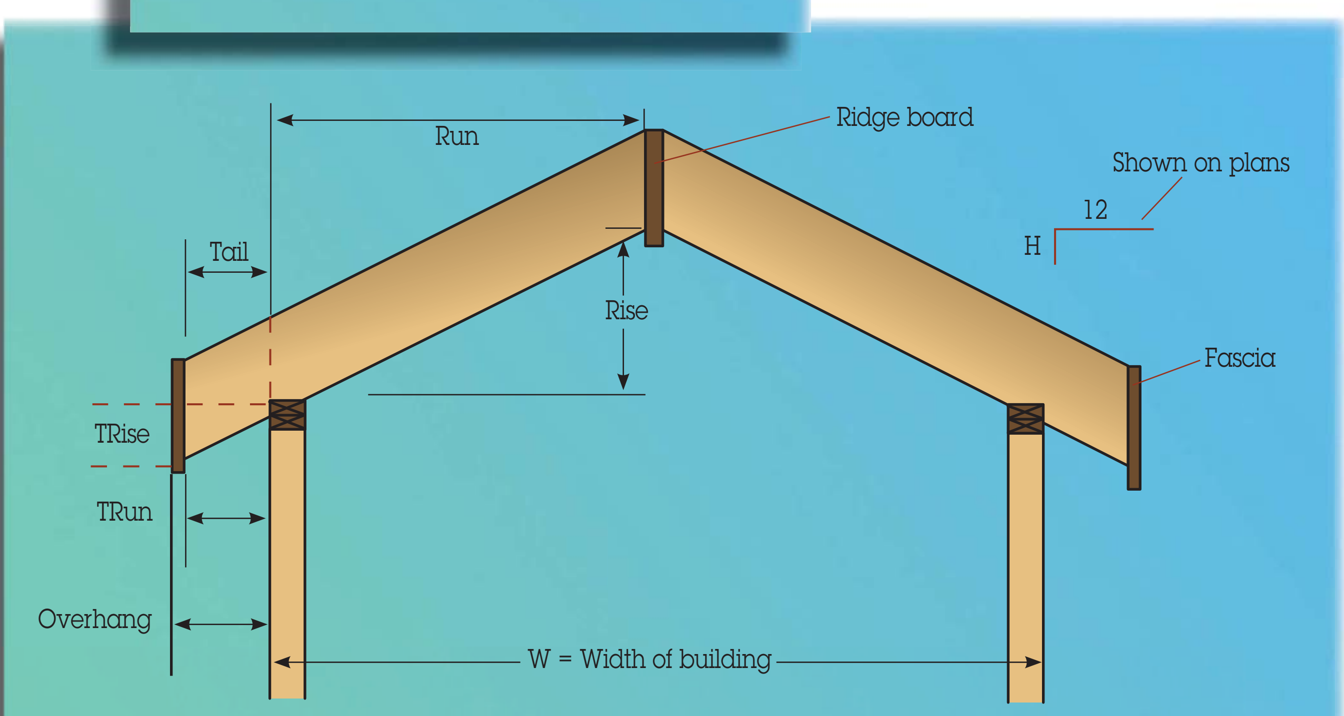
Third, find the rafter length by using this formula:

Rafter Length = $\sqrt{(\text{Rise} \times \text{Rise}) + (\text{Run} \times \text{Run})}$

Framer-Friendly Tips

If math is not your strong point, skip this method and try the "chalking lines duplication" method.





A. Pythagorean Theorem *(continued)*

To apply this formula, multiply Rise × Rise, and then Run × Run. Add the two products, then press the square root key on your calculator. The result is the Rafter Length.

Finding Rafter Tail (T) Length

First, find the TRun by using the following formula:

TRun = Overhang – Fascia

Second, find the TRise using the following formula:

TRise = H/12 × TRun

Third, find the Rafter Tail Length by using the following formula:

Rafter Tail Length =
$\sqrt{(\text{TRise} \times \text{TRise}) + (\text{TRun} \times \text{TRun})}$

Note: Be sure to mark crowns on rafters prior to measuring and cutting. Crowns are always up.

Example: Finding Rafter Cut Length

Rafter Length: Let the pitch be $_{4}\ulcorner^{12}$ and the building width be 20' and the ridge board be 1½" thick.

Step 1: Run = ½ (20') – ½ (1½") = 9'-11¼"

Step 2: Rise = $^4/_{12}$ × 9'-11¼"
= .3333 × 119.25"
= 39.75
= 39¾"

Step 3: Rafter Length = $\sqrt{(119.25 \times 119.25) + (39.75 \times 39.75)}$
= $\sqrt{14{,}220.56 + 1{,}580.06}$
= $\sqrt{15{,}800.62}$
= 125.70
= 125 $^{11}/_{16}$"

Rafter Tail Length: Let overhang be 2' and fascia be 1½".

Step 1: TRun = 2' – 1½" = 1'-10½"

Step 2: TRise = $^4/_{12}$ × 1'-10½"
= .3333 × 22.5" = 7.49
= 7.49
= 7½"

Rafter Cut Length = 125 $^{11}/_{16}$ + 23$^{11}/_{16}$
= 149 $^3/_8$"Step

Step 3: Rafter Tail Length = $\sqrt{(7.49 \times 7.49) + (22.5 \times 22.5)}$
= $\sqrt{56.10 + 506.25}$
= $\sqrt{562.35}$
= 23.71
= 23 $^{11}/_{16}$"

TRun = length of a horizontal line from the building's exterior wall to the outermost point on the fascia (overhang distance). (See diagram on page 76.)

TRise = Amount of vertical rise in the length of TRun.

B. Framing-Square Rafter Method

Steps

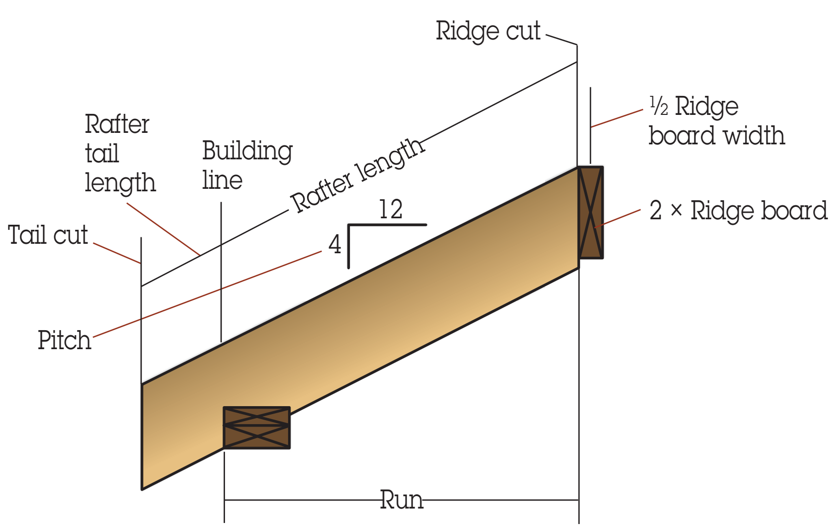
1. Find pitch of roof from plans.
2. Find pitch on framing-square inch line.
3. Find multiplication factor below pitch number.
4. Find run of rafter and multiply by multiplication factor.
5. Subtract ½ thickness of ridge board to determine the rafter length.

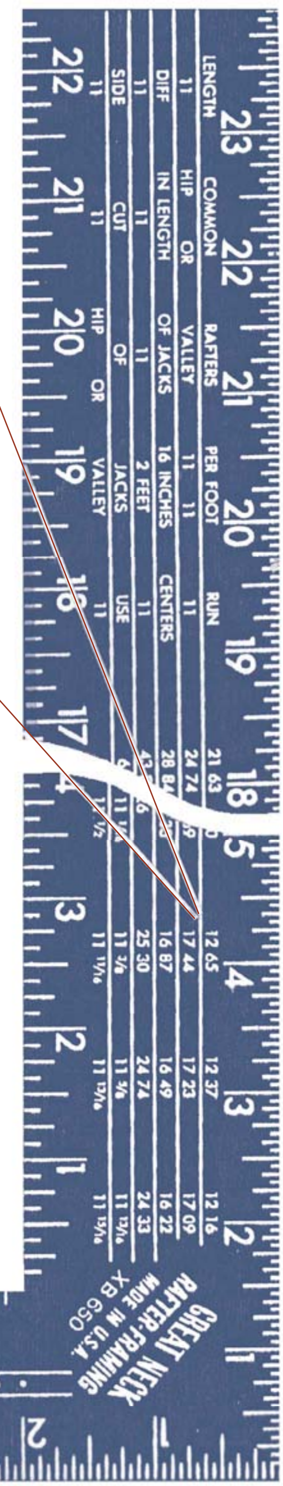
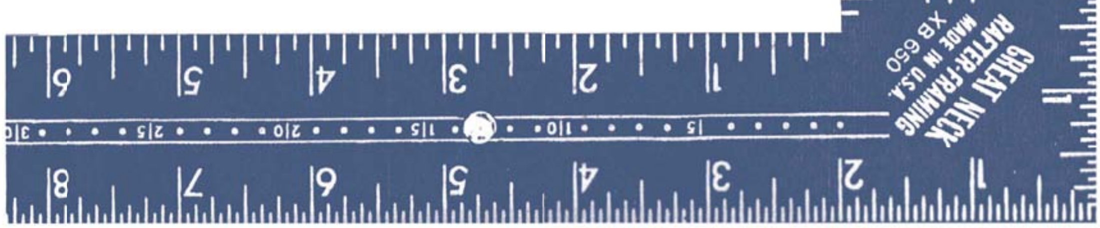
Example: 12

Let the pitch be 4 and the run be 10′.

Step 1 = 4
Step 2 = 4
Step 3 = 12.65
Step 4 = 10 × 12.65 = 126.5"
Step 5 = 126.5" – ¾" = 125.75" rafter length

Rafter Tail Length for overhang is found using the same method as for the rafter length, except that Step 5 (subtraction for ridge board) is eliminated. The rafter tail length is then added to the rafter length to produce the rafter tail cut length.



C. Framing Square Stepping Method

The pitch of the roof is given on the plans in this way:

$$6 \overline{\lfloor 12}$$

The number 12 is constant and indicates 12 inches of run, or horizontal distance. The other number represents the rise and varies, depending on how steep the roof is. In the example below, for every 12" of run, or horizontal distance, there is 6" of rise, or vertical distance. The greater this number, the steeper the roof.

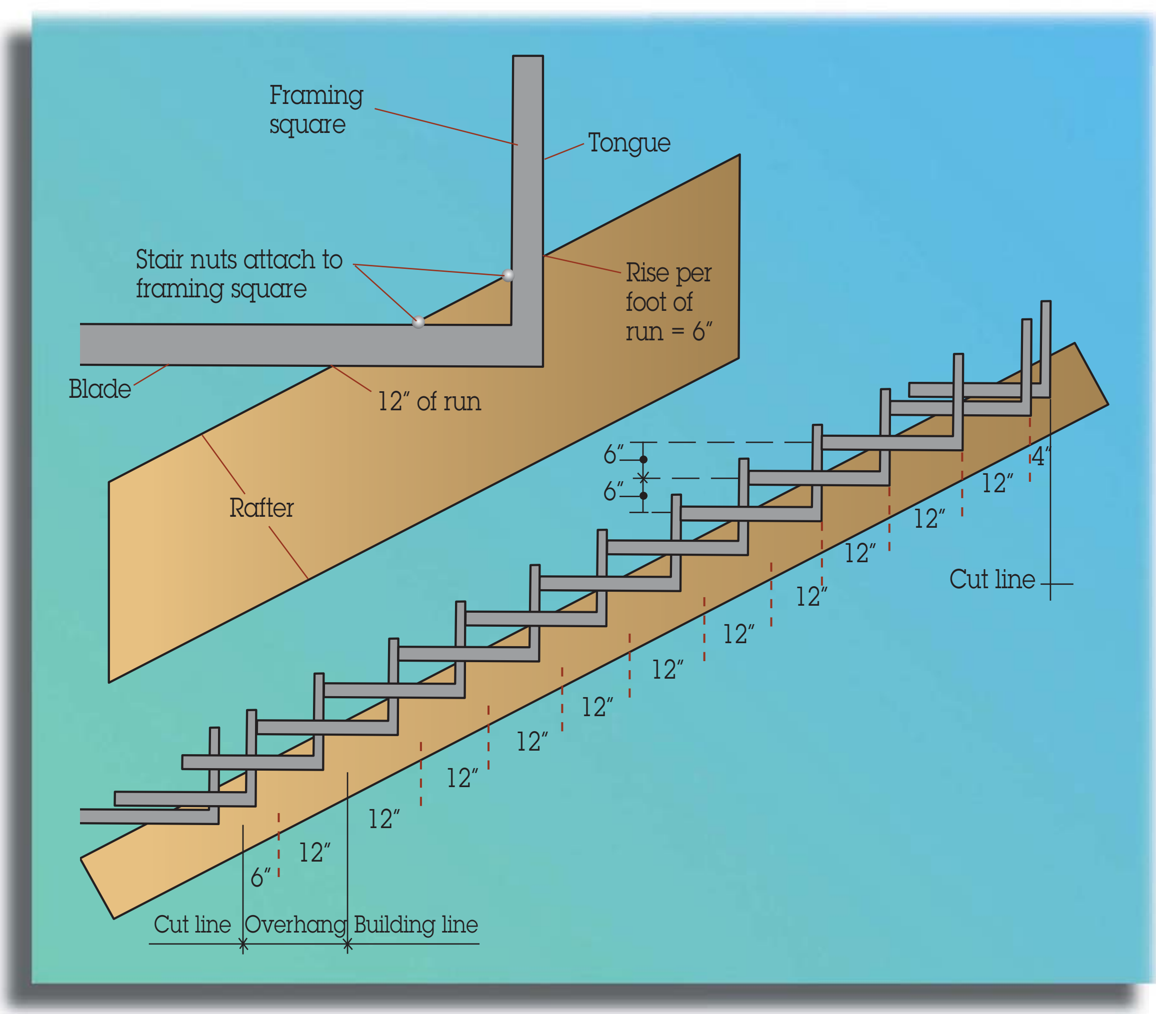
To find the rafter length, first lay the framing square on the rafter at 12" on the blade and the amount of rise on the tongue, 6". Once the framing square is set with stair nuts, just step off the amount of run along the rafter.

Example

Let the run equal 10'-4"

Let the overhang equal 1'-6"

1. Set framing square with stair nuts: the run 12" on the blade; the rise 6" on the tongue.
2. Step off 11'.
3. Perpendicular to the end lines, mark 4" (top), and 6" (bottom). Place the square at those marks to draw the plumb lines for the ridge and tail cuts.



D. Chalking Lines Duplication Method

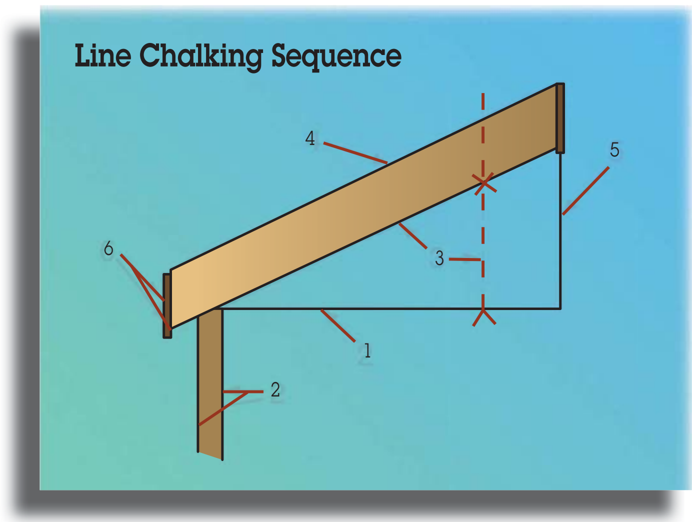
This method is probably the easiest to use. To find the lengths of rafters, you make an actual size drawing of the rafter on the floor and then measure the length.

All the information you need to use this method should be on the plans. First you will need the *pitch*. (See Method C mentioned previously.) Second is the *span*, which is the distance from the support on one side of the rafter to the support on the other side. Third is the *width* of the rafter, the length of the roof overhang, and the size of the exterior wall.

Steps (shown in Line Chalking Sequence illustration):

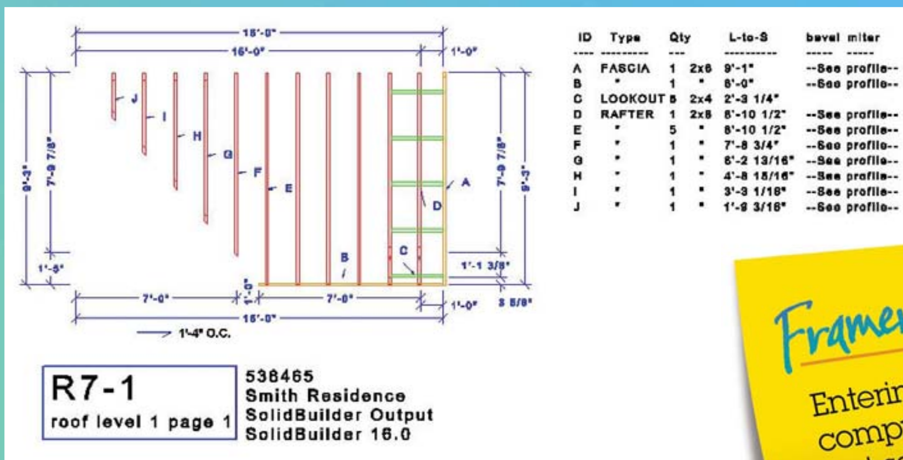
1. Chalk a straight line longer than the length of your rafter, which would represent the bottom of the ceiling joist if there were a ceiling joist.
2. Chalk two lines perpendicular to the first line to represent the exterior wall.
3. From the point where your inside exterior wall line crosses the ceiling joist line, measure out and up according to your pitch $\times^{12}$. For this example let your pitch equal 6^{12}. Therefore, for every 12" you measure out, you measure 6" up. The longer the distance out, the greater your accuracy. Make sure that the line up is exactly perpendicular or square. You can use surrounding walls that are square to measure from or measure a 3-4-5 triangle.
4. Chalk a line for the thickness of the rafter.
5. Measure the distance for the span along the ceiling joists line, then make a perpendicular line up and mark the ridge board.
6. Measure the distance of the roof overhang and draw in the fascia board.

With these lines in place, you can measure all the lengths you will need to cut your rafters.



Chalking rafter lines

Roof Production

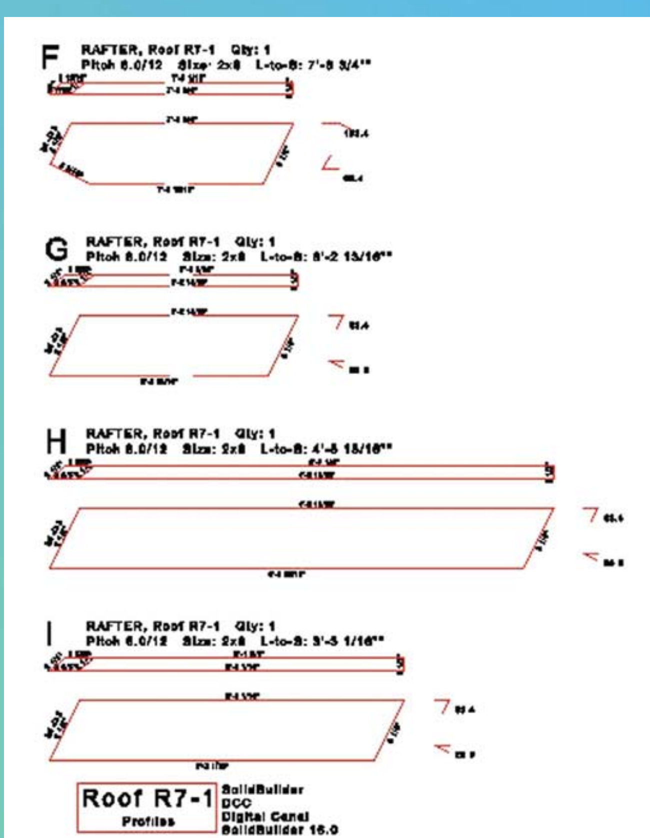


ID	Type	Qty		L-to-S	bevel	miter
A	FASCIA	1	2x6	9'-1"	--See	profile--
B	"	1	"	8'-0"	--See	profile--
C	LOOKOUT	5	2x4	2'-3 1/4"		
D	RAFTER	1	2x8	8'-10 1/2"	--See	profile--
E	"	5	"	8'-10 1/2"	--See	profile--
F	"	1	"	7'-8 3/4"	--See	profile--
G	"	1	"	6'-2 13/16"	--See	profile--
H	"	1	"	4'-8 15/16"	--See	profile--
I	"	1	"	3'-3 1/16"	--See	profile--
J	"	1	"	1'-9 3/16"	--See	profile--

Framer-Friendly Tips

Entering the information into a computer is time-consuming, but some software designed for architects can save time by producing rafter cut calculations.

Rafter Profiles



E. Computer Software Method

Using the methods described on previous page to find the lengths and angles for cutting rafters is not easy, but it is at least organized—and with a calculator that works in feet and inches and that figures the diagonals automatically, the process is straightforward. However, the easiest method is to use the computer. There are software programs currently available that will do all the work for you and produce a sketch of each rafter. Solid Builder is one of these programs. The illustrations on this page were done in Solid Builder. "Roof Production" identifies the type of roof parts, the quantity, lumber, and strength. "Rafter Profiles" illustrates the individual rafters with the balance of information you will need for cutting the rafters.

The hardest part of producing these computer-generated diagrams is learning the software and then entering the information needed for

each structure in order to generate the diagrams. However, for the architect who has already drawn up the plans, or the builder who is working with computer-generated plans, it is an easy task to produce these rafter profiles. If computer-generated rafter profiles were prepared and attached to plans, it could really make framing roofs a breeze.

F. Diagonal Percent Method

The length of a rafter can be found by determining the horizontal length (run) that it covers, and the pitch of the roof. The constant relationship between these factors is defined as the **diagonal percent**. This percent is constant for any common or jack rafter on any roof that has the same pitch. To find the length of a rafter, multiply the length of the run by the diagonal percent. For example, if you have a roof with a 6/12 pitch and a run of 6'-11$^{1}/_{4}$", you multiply 6'-11$^{1}/_{4}$" by 1.118 (diagonal percent for a 6/12 pitch) and find that your rafter length is 7'-9$^{1}/_{16}$". With a construction calculator, enter 7' × 1.118, and it will read 7'-9$^{1}/_{16}$". The illustration below provides the diagonal percent for common pitch roofs. To figure the length of hip and valley rafters, use the hip-val diagonal percent shown on the chart.

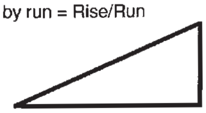
When you use the diagonal percent, the most difficult part of figuring rafter length is finding the length of the run. The adjustments that need to be made at the top and bottom of the rafter should be added and subtracted from the run before the rafter length is calculated. In finding the run, it is best to start with the full run distance from the outside of the bearing wall to the framing point of any connecting framing member. Use the framing point for consistency, and then make adjustments from there.

Diagonal Percent Chart

PITCH	RP-Rise Percent	DP Diagonal Percent	SAW ANGLE	HDP-Hip Diagonal Percent
1/12	0.083	1.003	4.5	1.002
2/12	0.167	1.014	9.5	1.007
3/12	0.25	1.031	14	1.016
4/12	0.333	1.054	18.5	1.027
5/12	0.417	1.083	22.5	1.043
6/12	0.5	1.118	26.5	1.061
7/12	0.583	1.158	30.25	1.082
8/12	0.667	1.202	33.75	1.106
9/12	0.75	1.25	37	1.132
10/12	0.833	1.302	40	1.161
11/12	0.917	1.357	42.5	1.192
12/12	1	1.414	45	1.225

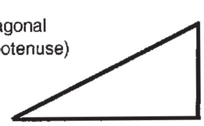
Rise Percent

RP = Rise Percent = Rise divided by run = Rise/Run



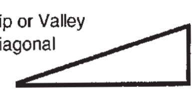
Diagonal Percent

DP = Diagonal Percent = Diagonal divided by Run = Diagonal/Run



Hip Diagonal Percent

HDP = Hip Diagonal Percent = Hip or Valley Diagonal divided by run = Hip Diagonal/Run



Framer-Friendly Tips

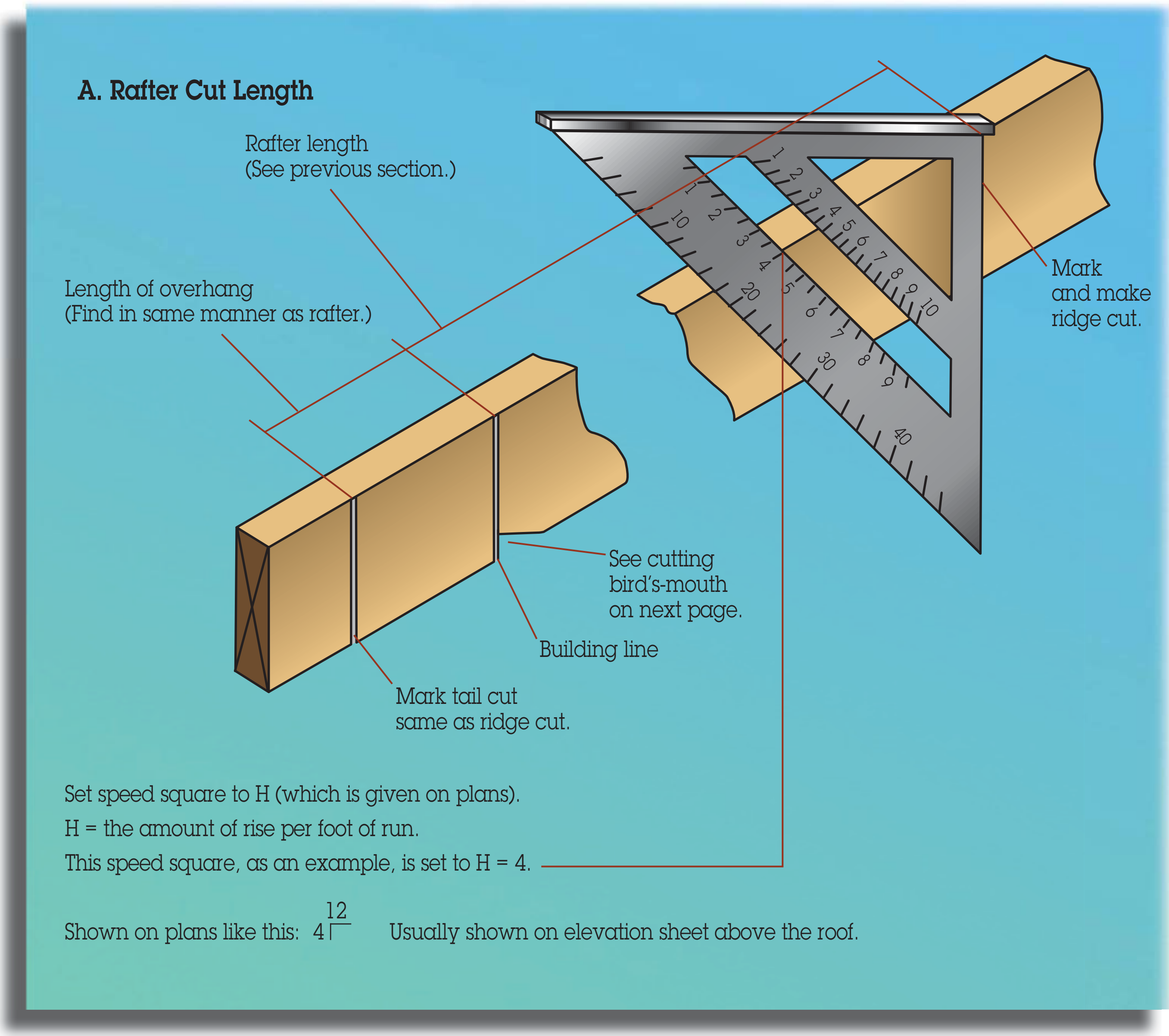
To get the rafter's length, measure the run and multiply it by the roof's diagonal pitch percent.

Step 2–Cut Common Rafter

The illustrations in this section show details on:

A. Rafter cut length
B. Bird's-mouth
C. Angle cuts

Cut a pattern first and try it for fit before cutting all the rafters. A framing square can also be used to mark cut lines. (See illustration in "Framing Square Stepping Method" earlier in this chapter.)

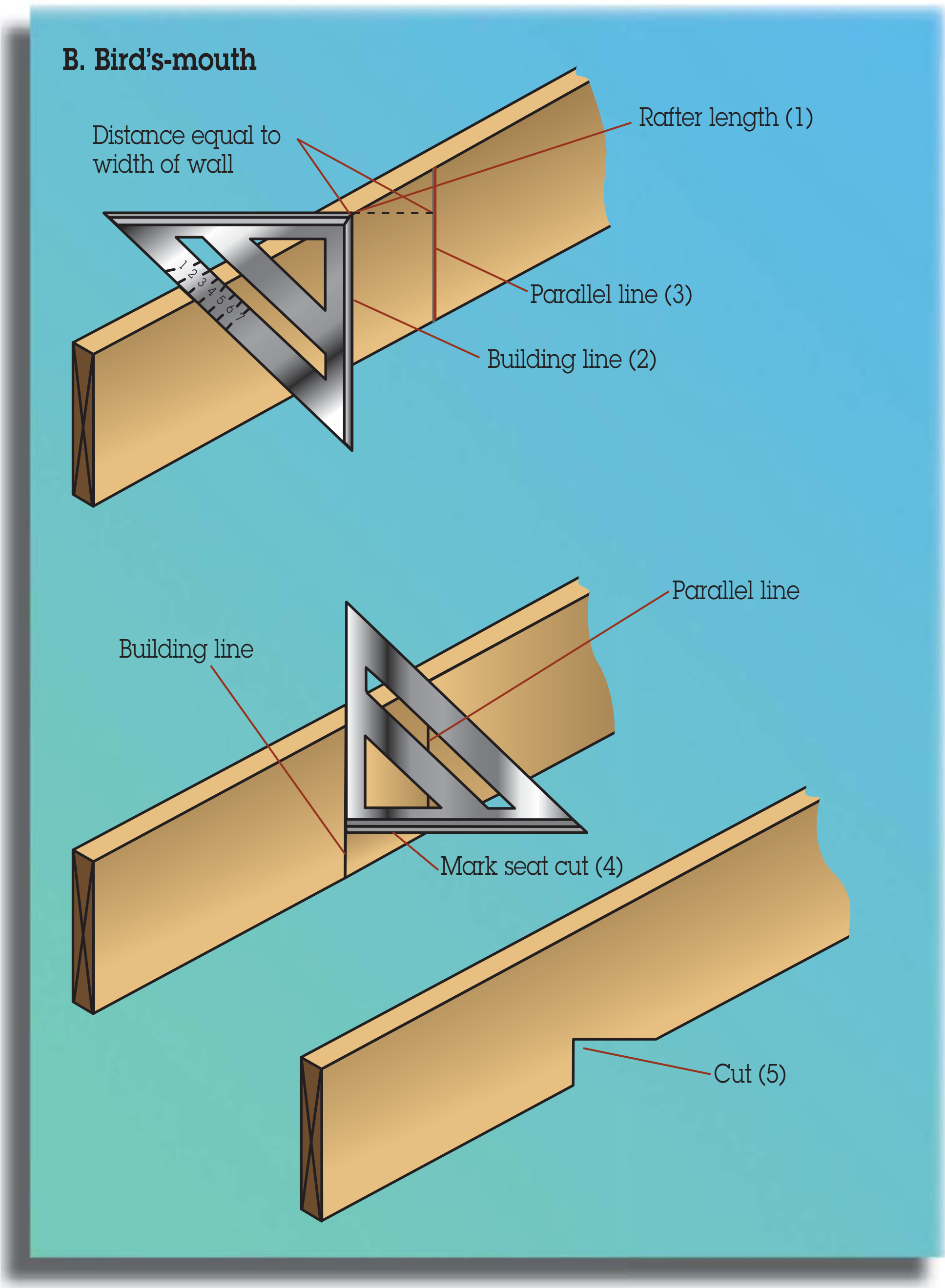


Step 2–Cut Common Rafter *(continued)*

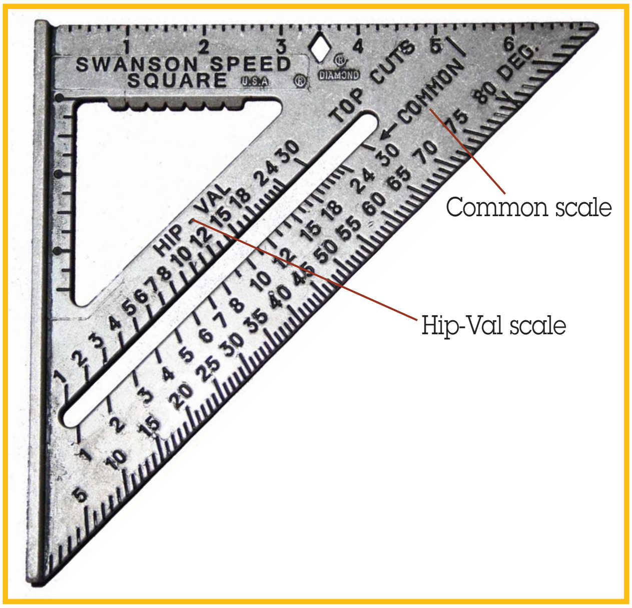
Steps (illustrated below):

1. Mark rafter length.
2. Mark building line at rafter length for the correct pitch.
3. Mark parallel plumb line a distance equal to width of wall and toward interior of building.
4. Mark seat cut square (90°) from building line at rafter length and bottom of parallel line.
5. Cut bird's-mouth.

A framing square can also be used to mark a bird's-mouth. (See illustration in "Framing Square Stepping Method" earlier in this chapter.)



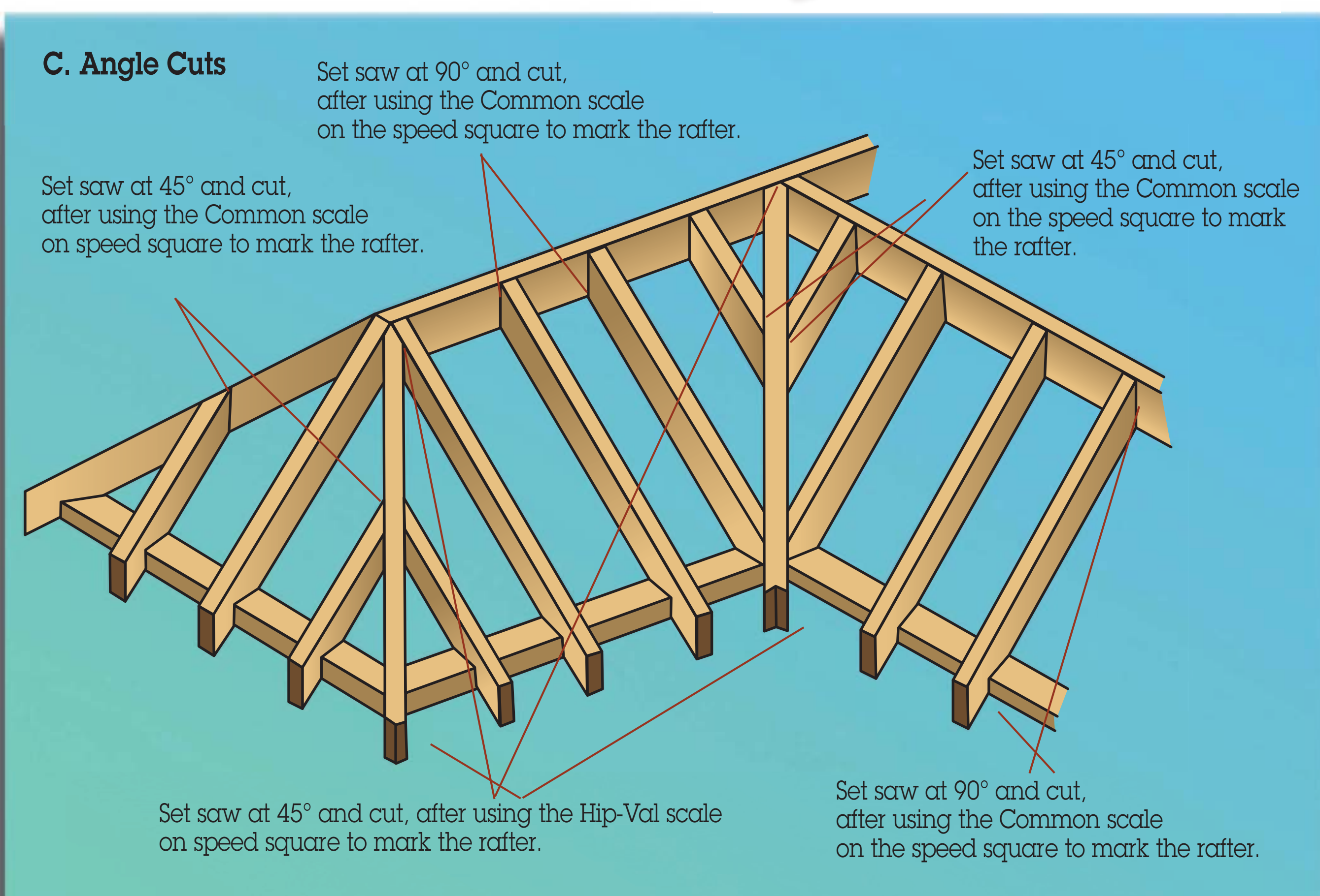
Step 2–Cut Common Rafter *(continued)*



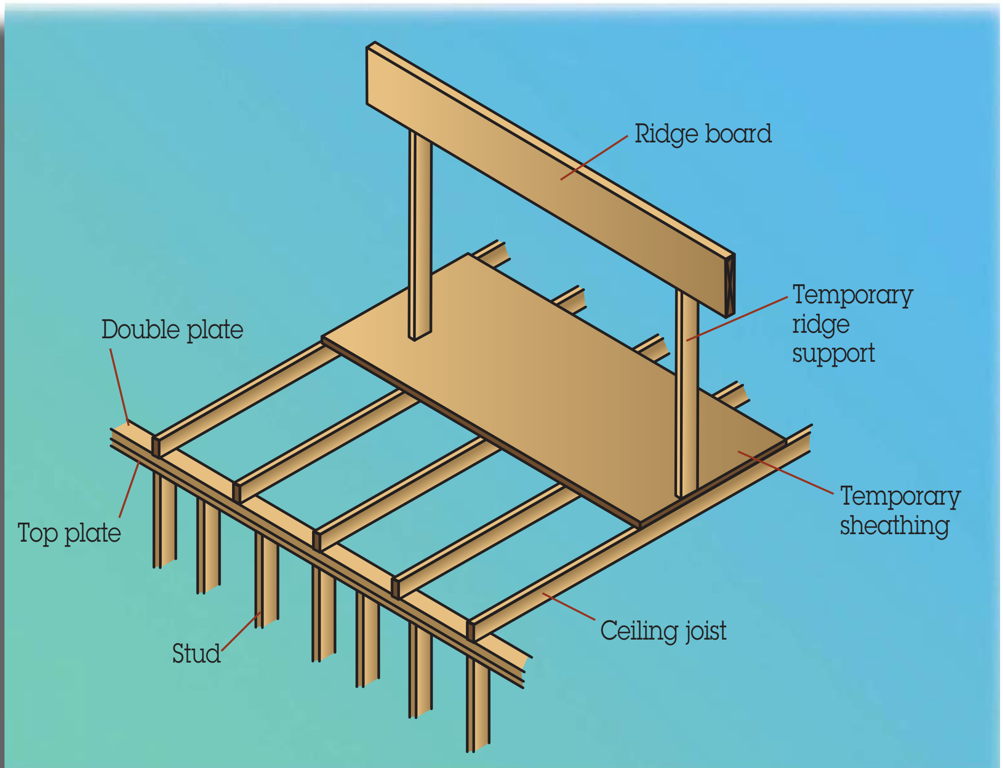
Use numbers on speed square to match pitch on roof

Framer-Friendly Tips

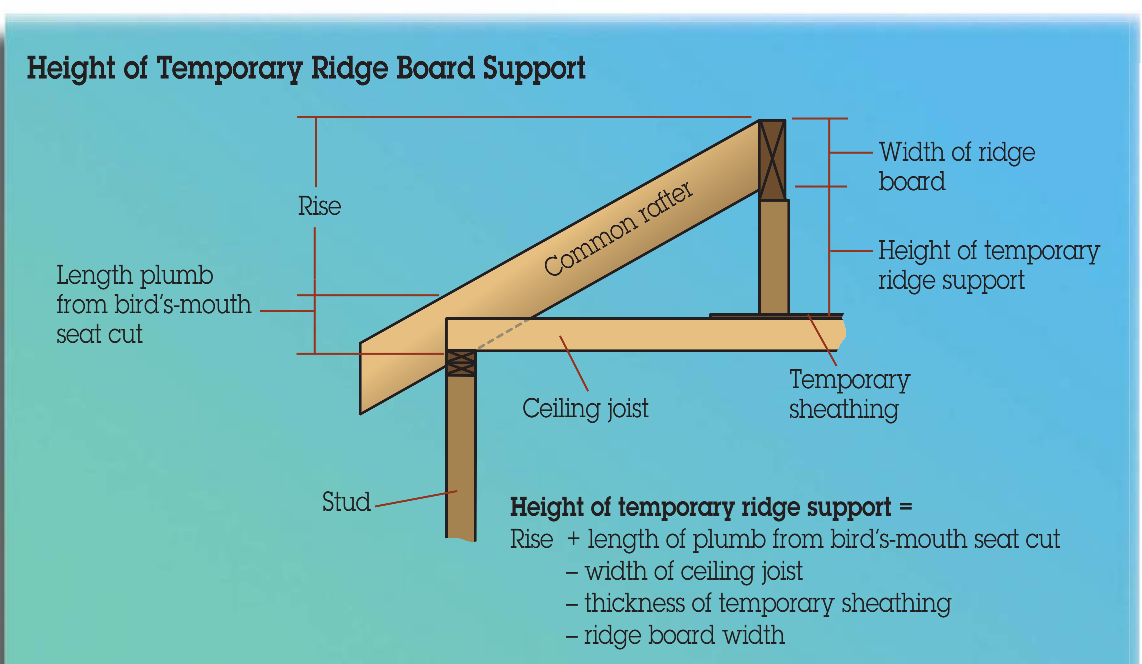
These angles only apply to 90° wall corners. Use the wall angle to find the rafter cut angle for non-90° angles.



Step 3–Set Ridge Board



Ridge board ready for rafters

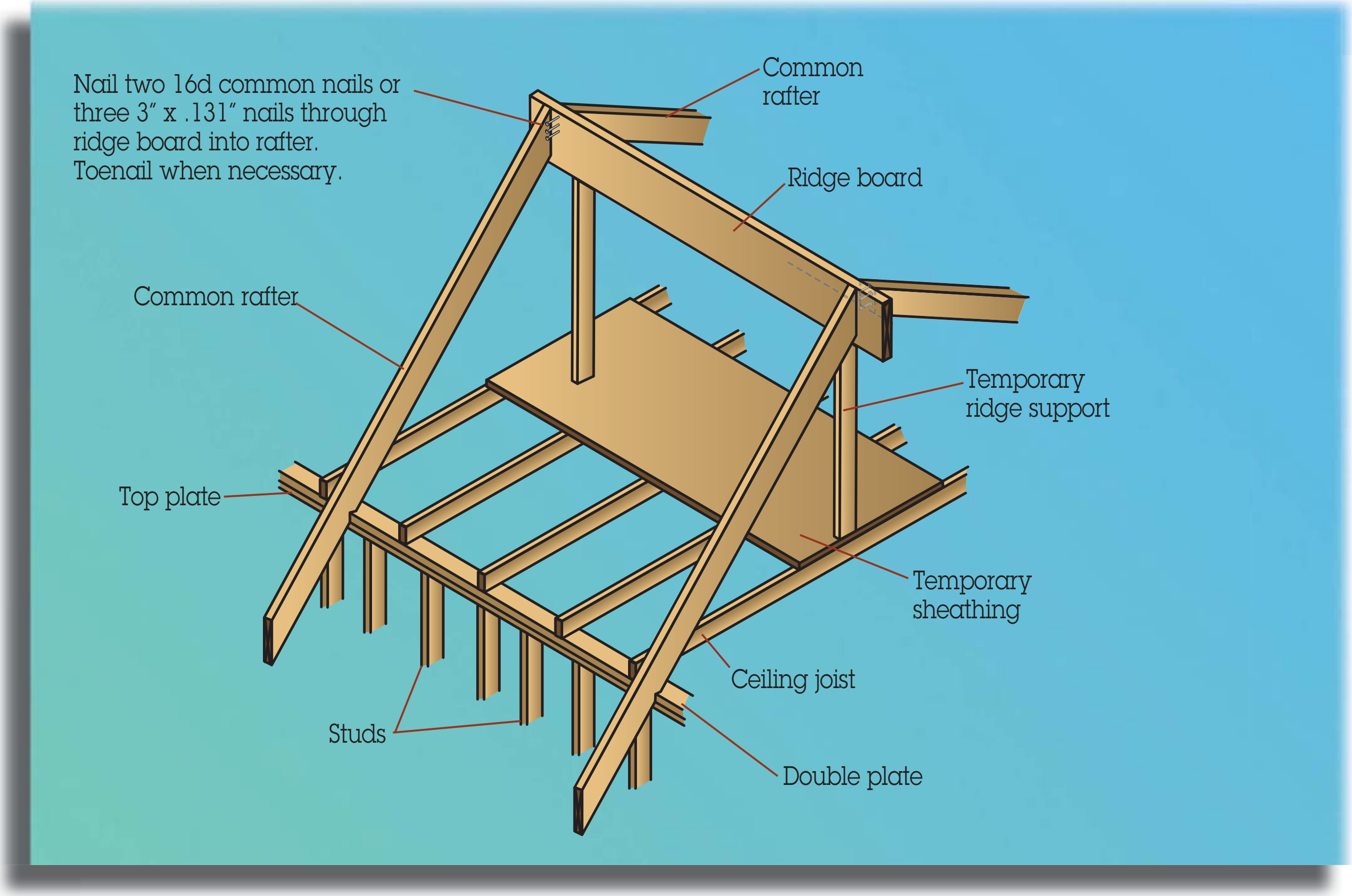


Formula for figuring temporary ridge board support height

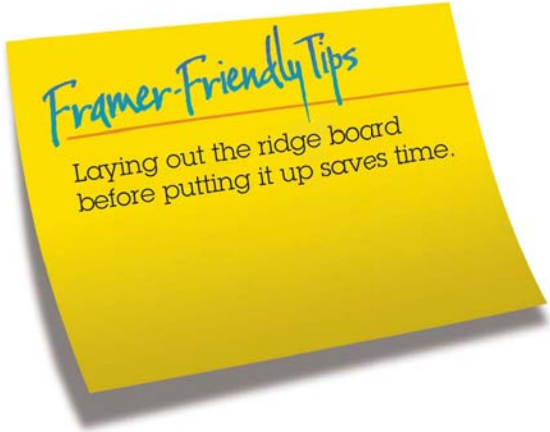
Step 4–Set Common Rafters

To start the ridge board layout, plumb a line up from a string held tight between roof layout marks on opposite walls. From that point, mark the ridge board layout to match the roof layout on the double plate.

Begin by setting the end rafters, as shown. Set the remaining rafters in the order that works best for you. As in lining a wall, attach a string in a similar manner along the edge of the ridge board. This will guide you in keeping a straight ridge board while you set the remaining rafters.



Here two pair of common rafters are fitted into place to secure the ridge board. Be sure to set end rafters first.



Step 5–Find Length of Hip & Valley Rafters

The length of the hip and valley rafters can be found by using any of the six common rafter methods previously described, and then making adjustments for the run and the top and bottom cuts.

Adjustment for the Run

For every 12" of common rafter run, there is 16.97" (17" approx.) of run for hip and valley rafters.

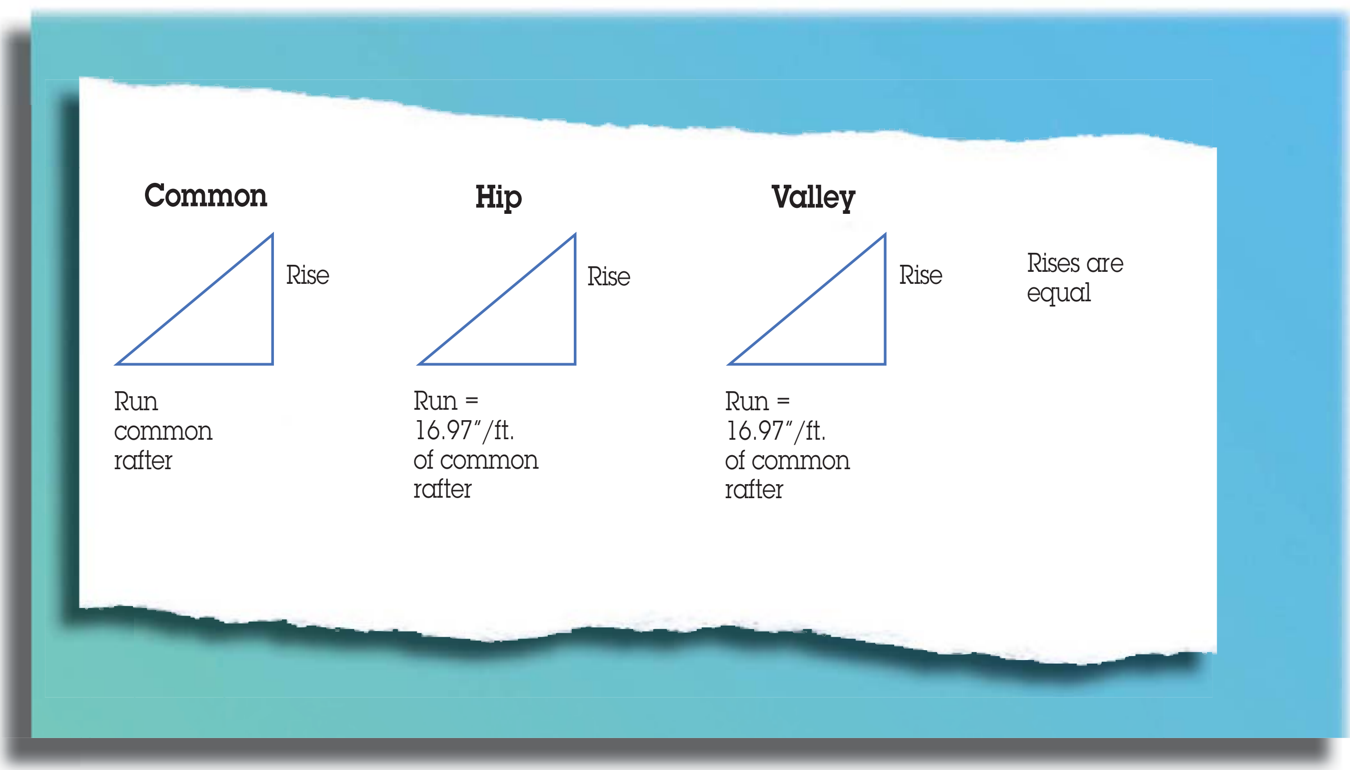
Multiply the run in feet of the common rafter by 16.97" (17" is commonly used) to get the run of the hip or valley rafter.

Adjustments for the Top and Bottom Cuts

The cut mark will be made similar to the common rafter cut mark, except that the hip-val scale on the speed square will be used instead of the common scale to mark the line to cut. (See “Rafter Cut Length” and “Angle Cuts” earlier in this chapter)

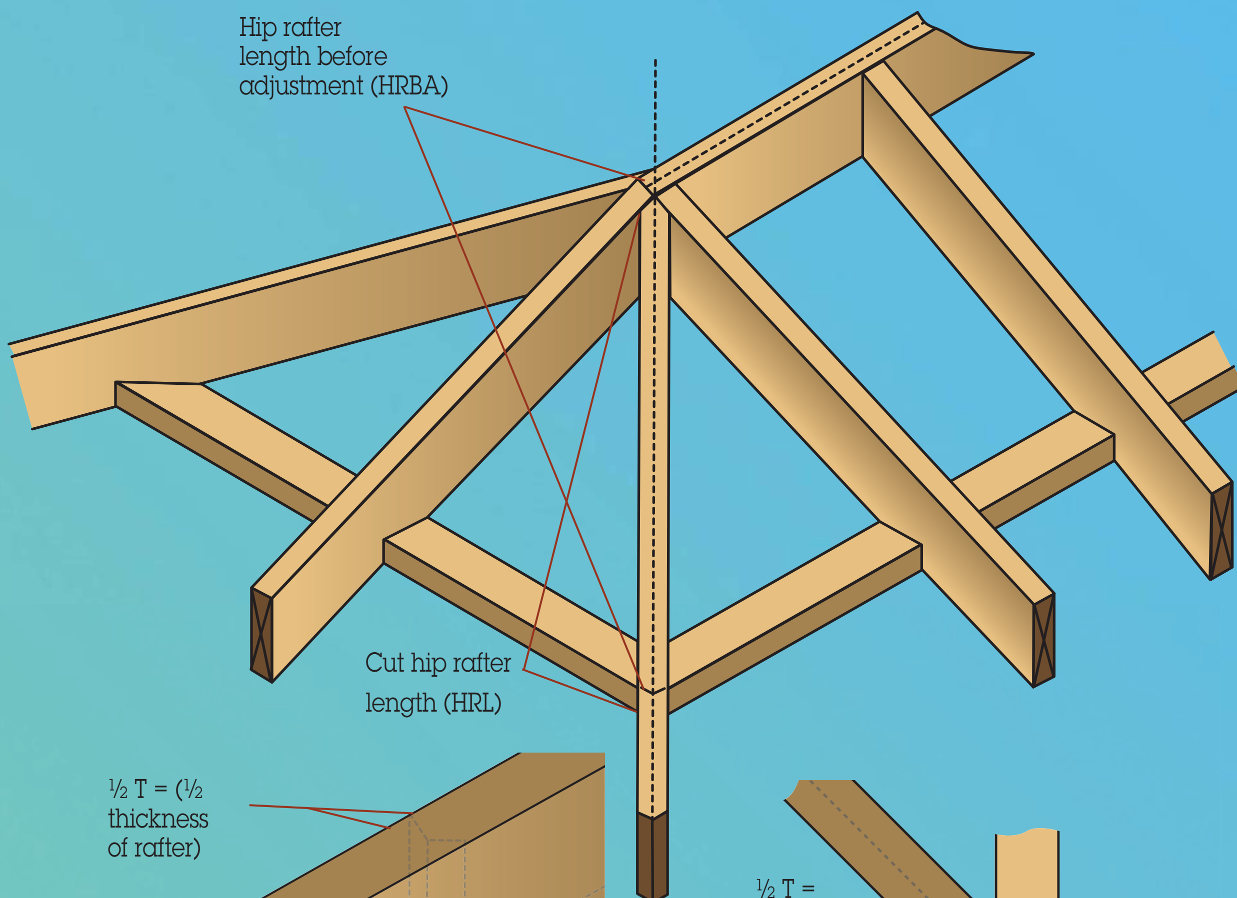
If a framing square is used, apply the same procedure shown previously, except use 17" instead of 12" along the blade of the framing square.

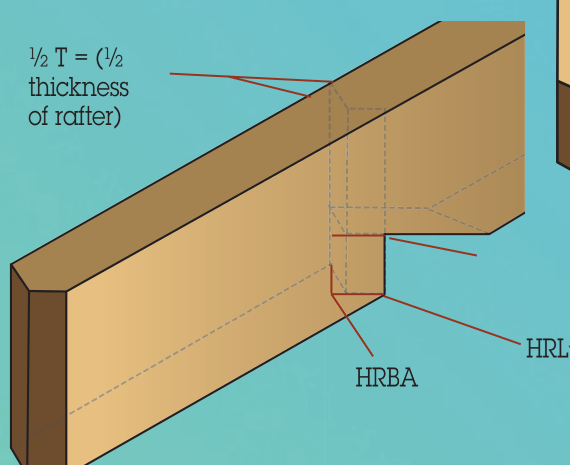
These procedures assume a hip or valley corner of 90 degrees.



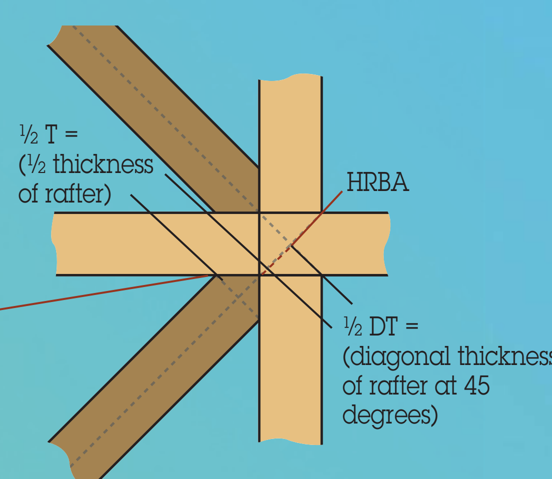
The relationship between common rafters and hip/valley rafters

Step 6–Cut Hip & Valley Rafters





Bottom Adjustment



Top Adjustment

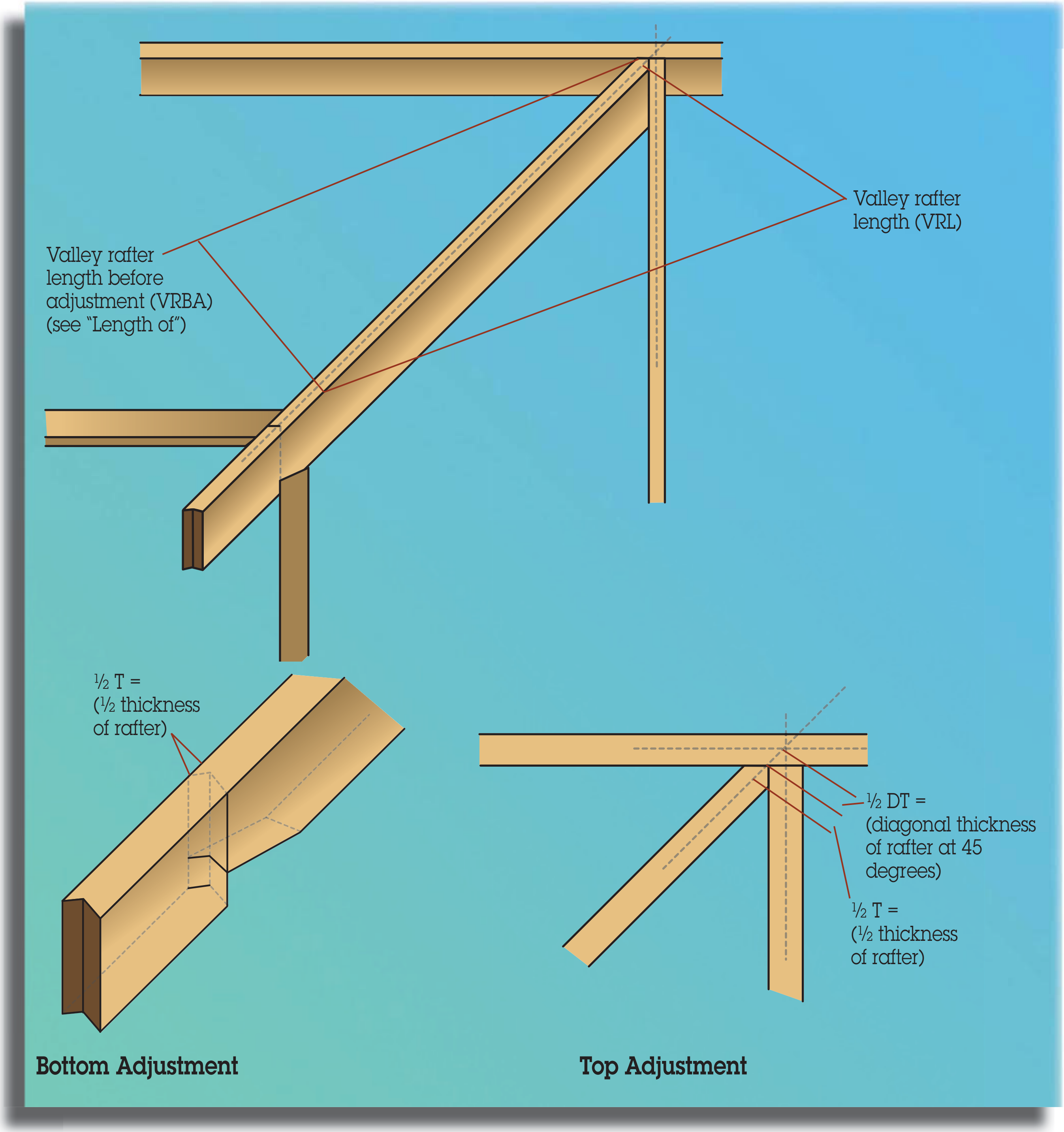
Hip Rafter Length (HRL) = Hip rafter length before adjustments (HRBA) – ½ diagonal thickness (DT) of rafter – thickness (T) of rafter (½ thickness top and bottom combined).

or:

HRL = HRBA – ½ DT – T

These figures are based on a 90-degree building corner.

Step 6–Cut Hip & Valley Rafters *(continued)*



Valley Rafter Length = Valley rafter length before adjustment – ½ diagonal thickness of rafter. (The ½ thickness factors cancel each other out.)

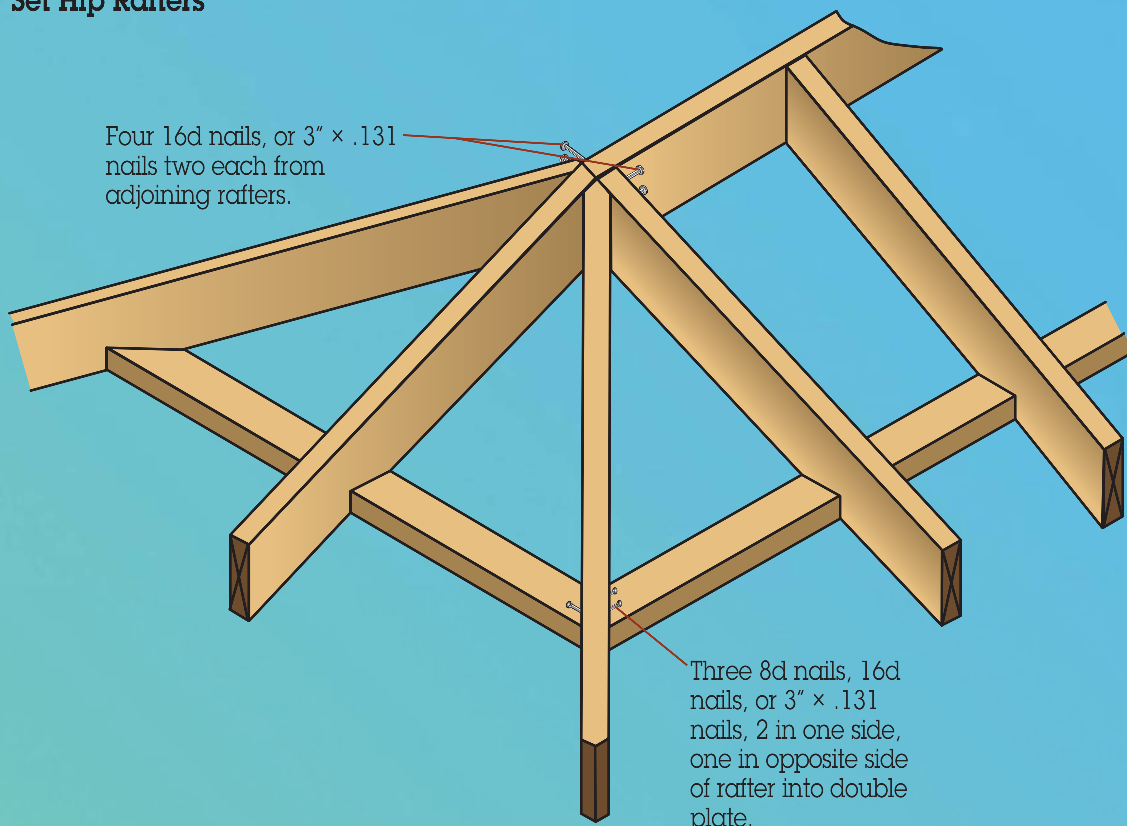
or:

VRL = VRBA – ½ DT

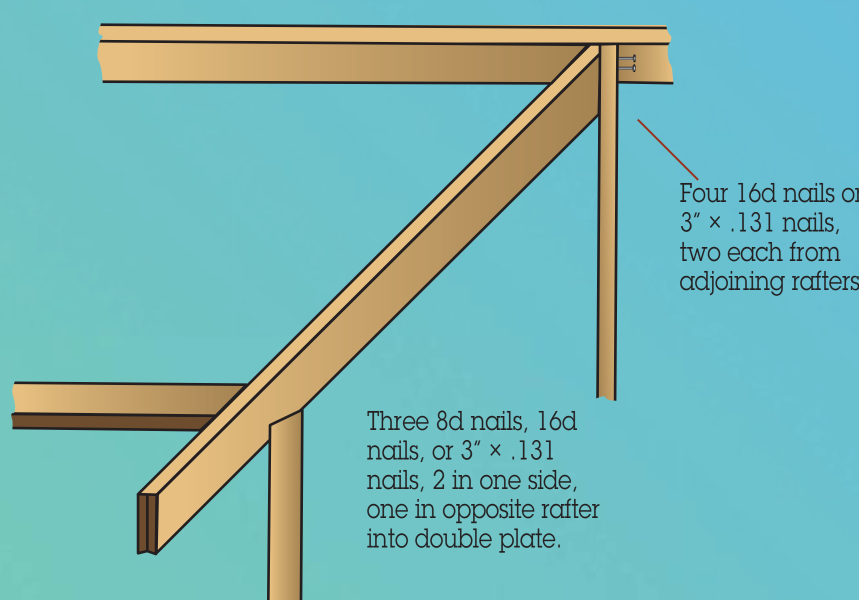
These figures are based on a 90-degree building corner.

Step 7–Set Hip & Valley Rafters

Set Hip Rafters

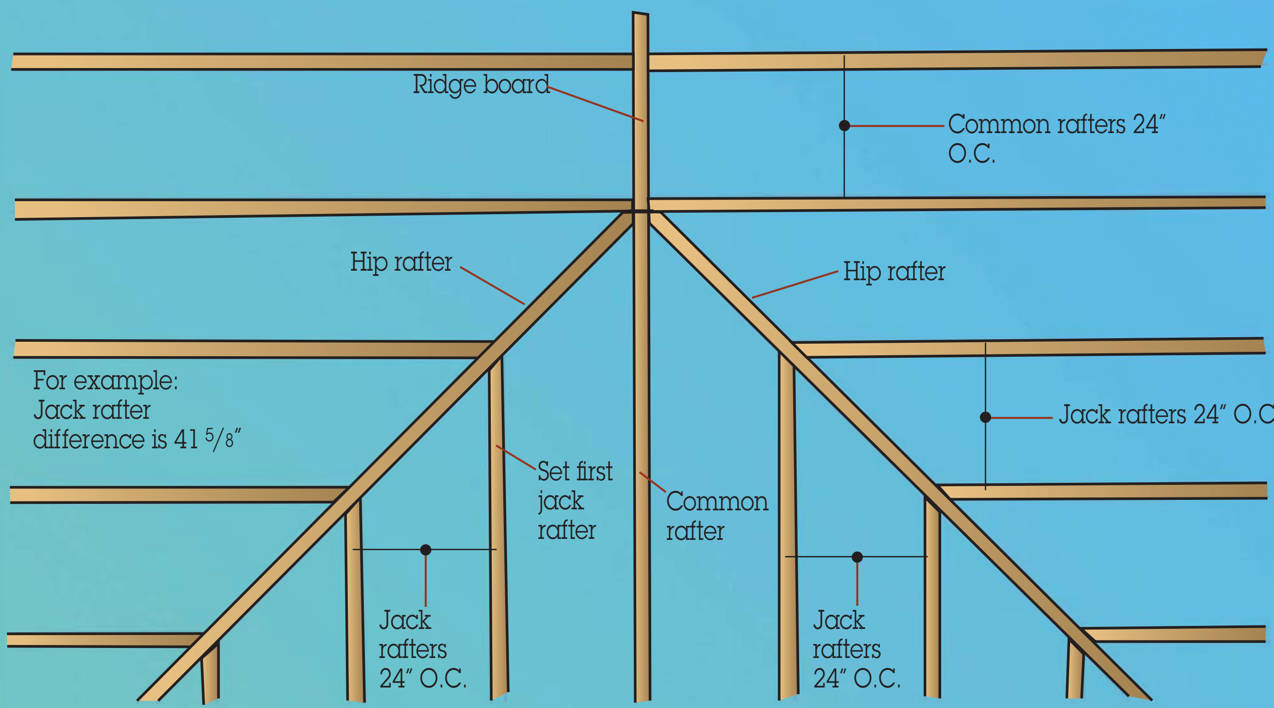


Set Valley Rafters



Note: If hip or valley rafters do not fit, first check your length calculations, then check walls for plumb and the ridge board for correct height and for plumb.

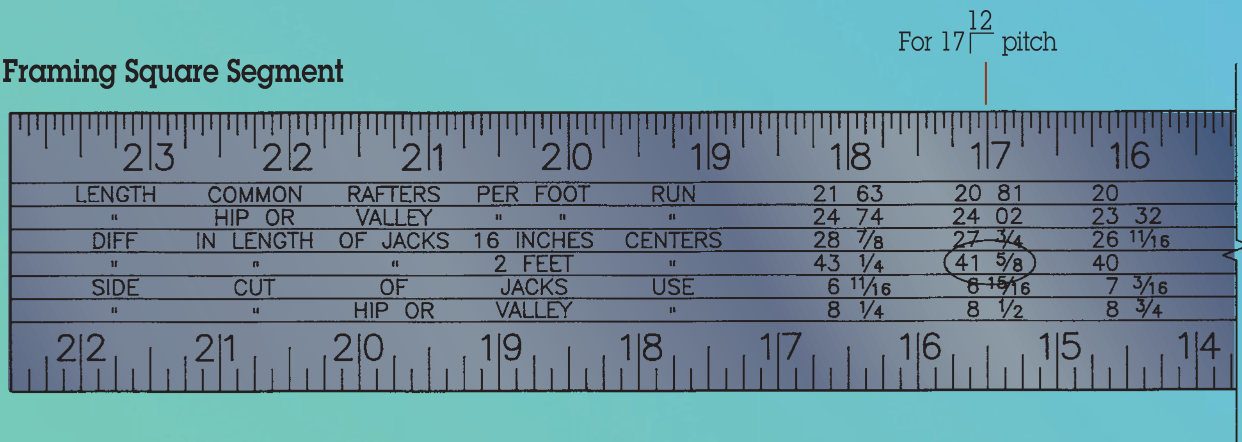
Step 8–Set Jack Rafters



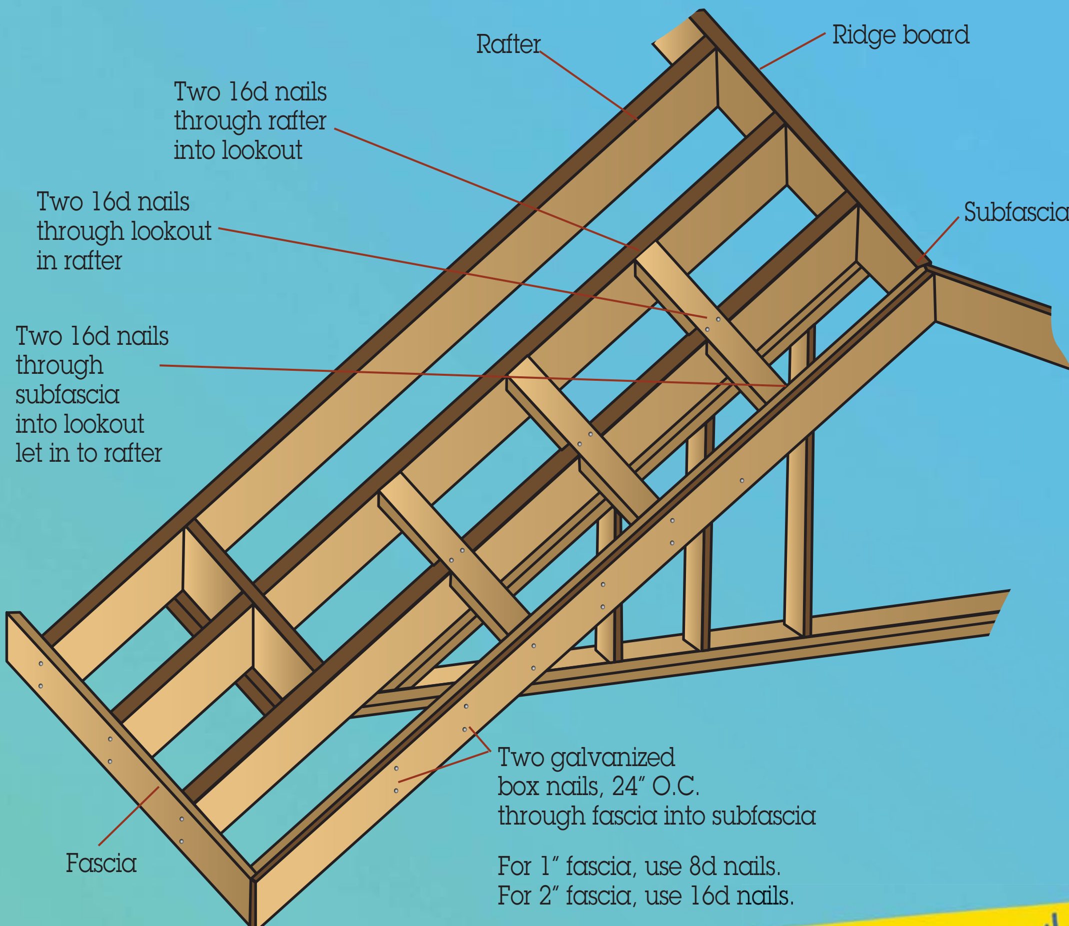
Set first jack rafter on 16" or 24" spacing with common rafters.

Measure length from common rafter to first jack rafter and then use standard jack rafter differences, as given in framing square table, to measure lengths of remaining jack rafters along the hip rafter.

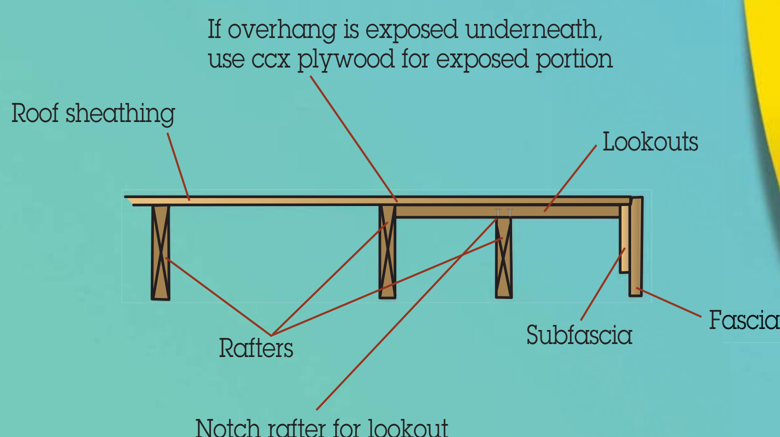
Framing Square Segment



Step 9–Block Rafters & Lookouts
Step 10–Set Fascia



Install blocks then lookouts, subfascia and fascia



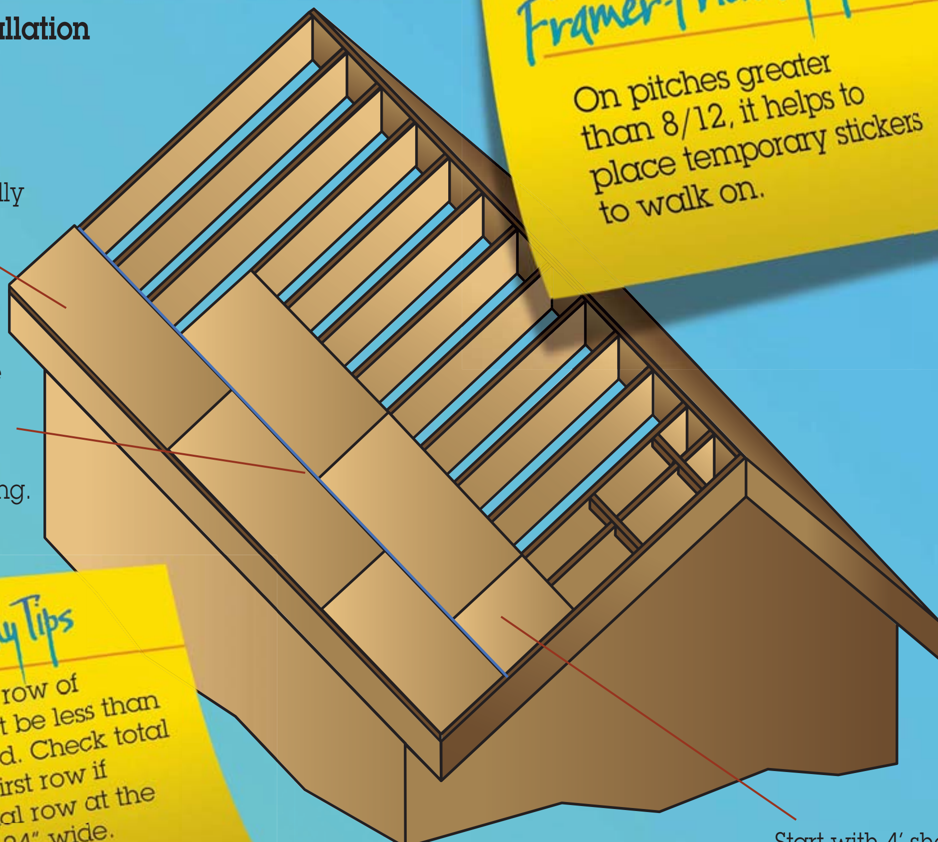
Roof overhang using lookouts for support

Framer-Friendly Tips

Look-outs need to be cut with precision because their lengths will establish the straightness of the fascia.

Step 11–Install Sheathing

Roof Sheating Installation



Framer-Friendly Tips

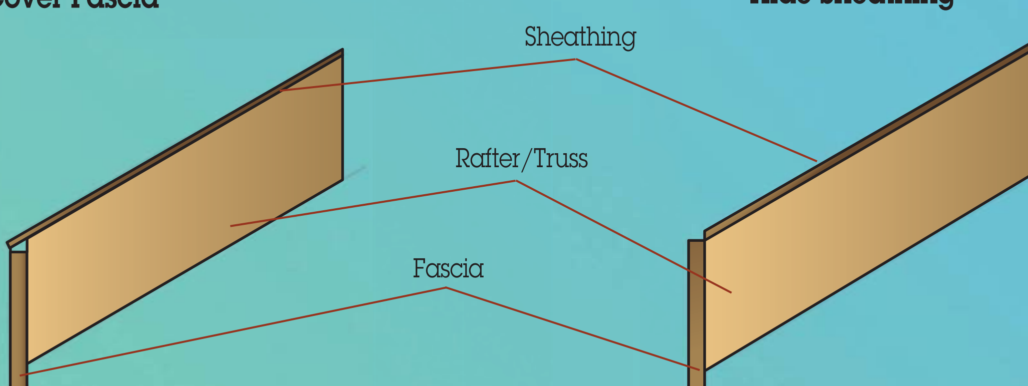
On pitches greater than 8/12, it helps to place temporary stickers to walk on.

Framer-Friendly Tips

The width of any row of sheathing cannot be less than 24″, if not blocked. Check total length and cut first row if necessary so final row at the ridge is at least 24″ wide.

Cover Fascia

Hide Sheathing

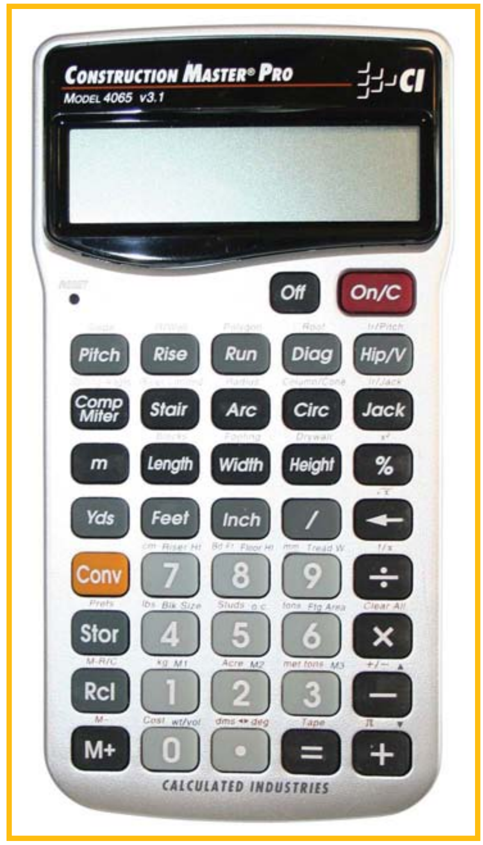


Sheathing covers fascia.

Fascia hides sheathing edge. Fascia is attached so that its top outer edge is in line with the plane of the top surface of the roof sheathing.

Rafter Guidelines

There are calculators that are made specifically for assisting with construction math. These are very helpful in finding rafter lengths. Construction Master IV® is one available calculator, which we will refer to and use in this chapter to demonstrate the process of finding rafter® lengths. These calculators make it easy to do the complicated math, working in feet and inches. The sequence of buttons takes a little time to master, but once you are familiar with them, you will never go back to pencil and paper.



Construction calculator designed to assist in construction math.

Learning by Example

The best way to learn cutting of rafters is to completely work through the actual process. The following example uses the diagonal percent method of finding rafter lengths. The example shows how to find the lengths of the parts of a relatively difficult roof. If you are able to work through this example and understand the processes, you should be able to figure out how to cut and stack rafters.

This example starts by organizing the whole process. Some of this information was presented earlier in the chapter, but it's important to review for every job. We'll start by outlining the important parts of cutting rafters.

Considerations for Cutting Rafters

When cutting rafters, you need to consider the following four factors:

1. Figuring rafter length
2. Figuring the Adjustment to rafter length at top and bottom
3. Finding the angle cuts at the top, bottom, and at the bird's mouth
4. Finding the bird's mouth height

Figuring Rafter Length

Figuring Rafter Length Using Diagonal Percent was shown earlier in the chapter with the six ways to figure rafter lengths. (See "F.") When you use the diagonal percent, the most difficult part of figuring rafter length is finding the length of the run. The adjustments that need to be made at the top and bottom of the rafter should be added and subtracted from the run before the rafter length is calculated. In finding the run, it is best to start with the full run distance from the outside of the bearing wall to the framing point of any connecting framing member. Use the framing point for consistency, and then make adjustments from there.

Figure the Adjustments to Rafter Length at Top and Bottom

Because there are so many different types of connections for rafters, it helps to establish certain standard ways to connect, and measure them in order to find the proper adjustments to length for the top and bottom. Following are some standard connections and their adjustments. They will not apply to every situation, but they will work for the most common roofs.

Adjustments for Common Rafters

1. Subtract half the thickness of the ridge board at the top.
2. At the bottom measure to the outside of the wall framing (not the sheathing).

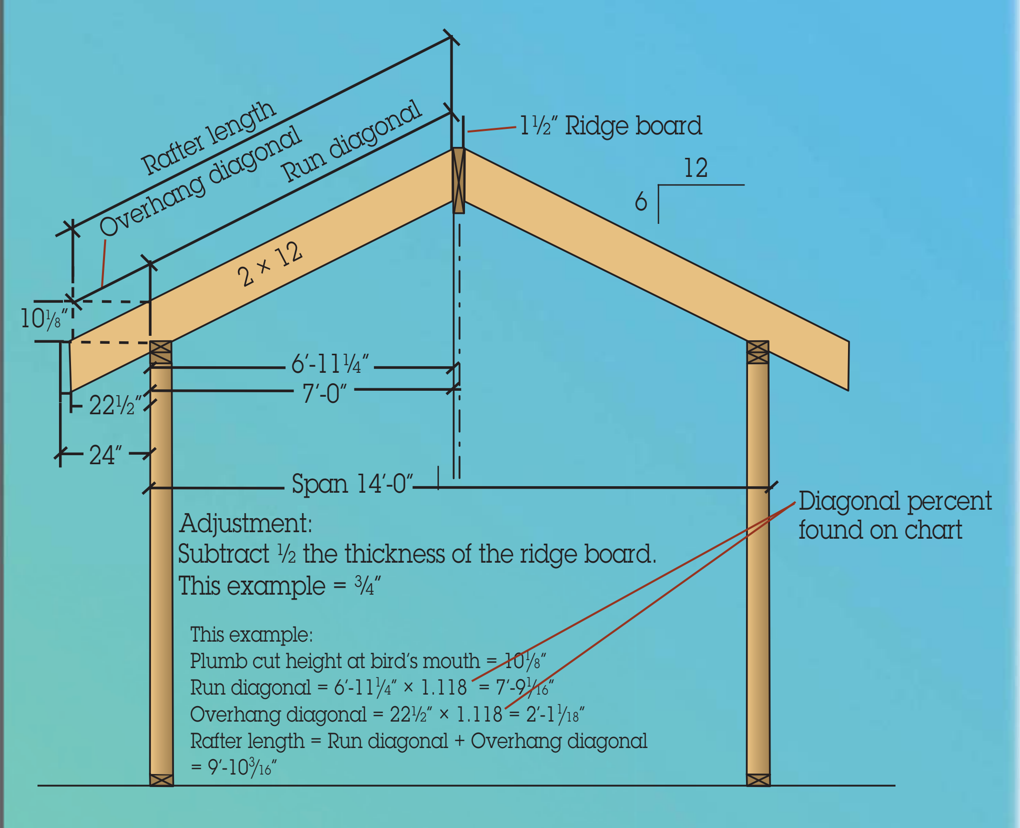
Adjustments for Hip and Valley Rafters

1. Subtract half the 45° thickness of the ridge board. (See "Connection # 1 [close-up] illustration later in this chapter.)
2. At the bottom, measure to the outside corner of the two connecting walls.

Adjustments for Jack Rafters

1. Measure to the framing point where it meets the hip or valley it is connected to. (See "Adjusting the Top Length for Jack Rafters" illustration later in this chapter.)
2. Subtract half the 45° thickness of the valley rafter.
3. When the rafter rests on an exterior wall, measure to the outside of the wall framing.

Adjust Length for Top of Common Rafter



Adjustments for Rafters Running Between Hips and Valleys

1. Measure to the framing points where it meets the hip or valley it is connecting to. (See "Adjusting the Top Length for Jack Rafters" illustration later in this chapter.)
2. Subtract half the 45° thickness of the hip or valley rafter at each end.

Adjustments for Miscellaneous Connections Between Hips, Valleys, Ridges, and Rafters

1. Find the combination of cuts that provides the greatest number of standard cuts and still provides a sound structural connection.
2. Measure to the framing point for making adjustments.
3. Connection #2 is an example of a miscellaneous connection where a ridge board, a common rafter, a hip rafter and a valley rafter connect. (See "Connection #2" illustration later in chapter.)

Finding the Angle Cuts at the Top, Bottom, and at the Bird's Mouth

It is easy to figure the angle cuts if you break them down into two separate angles. The first is the **pitch angle**, and the second is the **connection angle**. The pitch angle is either a common or a hip/valley. If you use a speed square, you don't even have to calculate it. If you are cutting a rafter that is not a hip or a valley, then use the common scale on a speed square for the pitch of your roof and draw your pitch angle line on the rafter. If you're cutting a hip or valley rafter, then use the hip-val scale on the speed square. The pitch angle line will be your cut line for your saw cut.

The connection angle depends on a lot of factors, but 45° and 90° are the most commonly used angles. Basically, you will be setting the angle of your saw at the connection angle and cutting the cut line created by the pitch angle. For 90° corners on hips and valleys, the connection angle for jack rafters will be 45°. For standard, common rafters, the top connection angle is 90°.

Finding the Bird's Mouth Height

The height of the bird's mouth will affect the height of the roof and possibly the interior design of the ceiling. The most common detail for a bird's mouth has the bird's mouth cut starting at the inside corner of the wall.

On a hip and valley, the inside corner won't align with the wall. Since the height of the hip and valley bird's mouth must be the same as the common rafter bird's mouth, you can simply measure the common rafter height and transfer it to the hip and valley bird's mouth. The chart on page 103 shows some common bird's mouth heights.

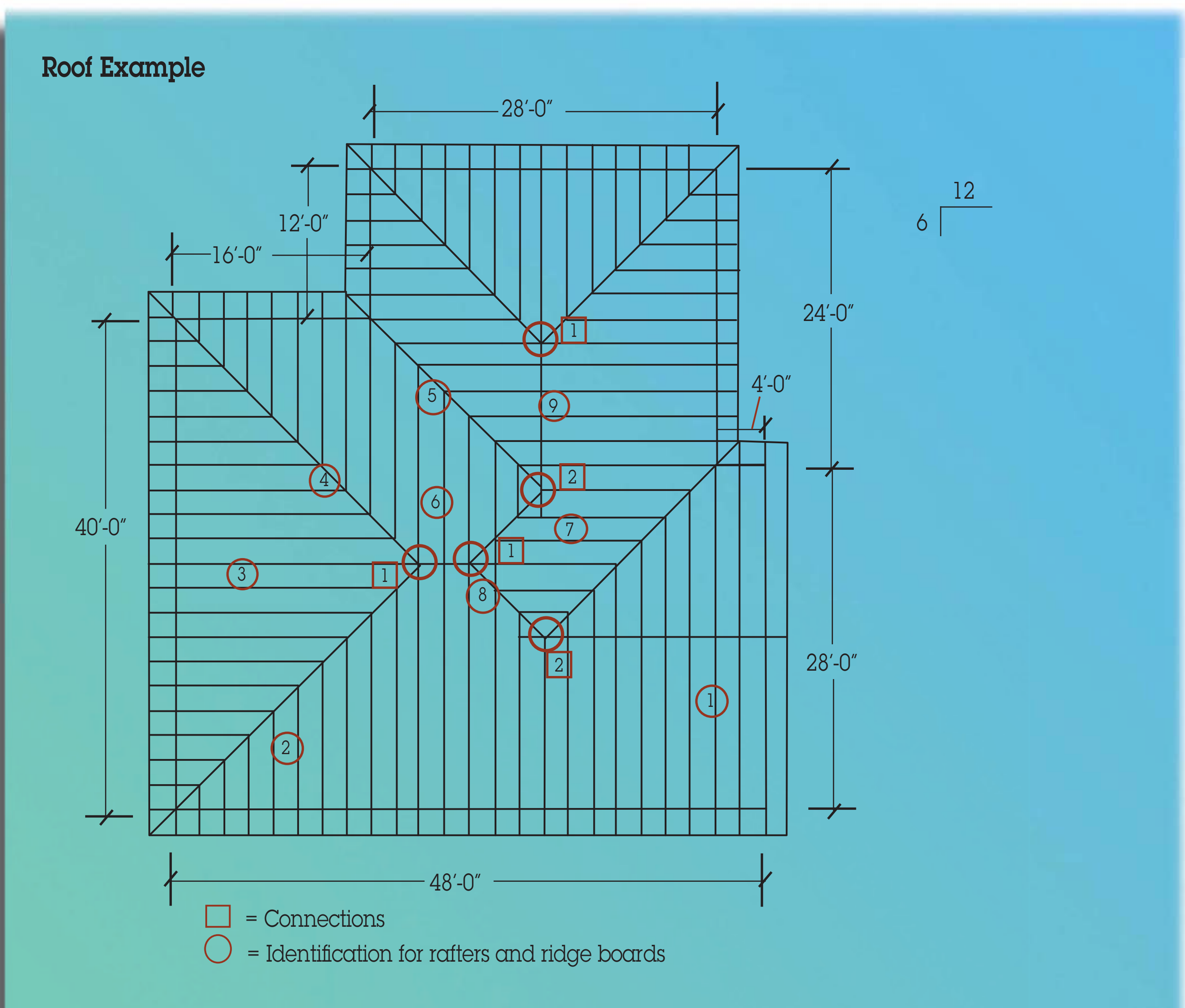
On hip rafters, you measure the height to the outside edge of the hip, whereas on valley rafters, it's a little tricky. You need to measure to the center of the valley, which is slightly higher than the outside edge.

Finding Rafter Length: Examples

Breaking the process of cutting rafters into the four basic characteristics described in this chapter helps to organize the task, but it is still a complicated process. Probably the best way to learn is to work through the steps in figuring individual rafters. The following illustration is an example of a roof that has a number of different rafters and a ridge board identified. Nine additional examples explain how to find the lengths for these rafters and ridge board based on the illustration.

Finding Common Rafter Length—Example 1 on Roof Example Illustration

The roof span at this area is 28'-0", making the run equal to ½ the span of 14'-0" minus half the thickness of the ridge board (3/4"). That makes the adjusted run 13'-11 1/4". Multiplying that times the diagonal percent for a 6/12 pitch roof (which is 1.118) gives a run diagonal length of 15'-7". If you add that length to the overhang diagonal of 2'-1 1/8", the rafter length is 17'-8 1/8". The overhang diagonal



is found by subtracting the fascia ($1\frac{1}{2}$") from the 2'-0" overhang, which gives ($22\frac{1}{2}$"), and multiplying by the diagonal percent 1.118.

Finding a Jack Rafter Length—Example 2 on Roof Example Illustration

Most hip rafters are on 90° corners, with the hip runs in the middle of the corner. Because the two sides of a triangle made by a 90° angle and two 45° angles are the same, the run of the jack rafter can be easily found.

The distance of your layout to the center of your rafter is the same distance as your run to the center of your hip. Just subtract one half the thickness of the hip at a 45° angle ($1\frac{1}{16}$") from the run, and multiply that figure by your diagonal percentage. Then add on your overhang diagonal length. This will give you your rafter length. In this example, the rafter is on layout at 8'-0", so we subtract $1\frac{1}{16}$" (half the thickness of the 1½" hip at 45°), giving 7'-$10\frac{15}{16}$", which is multiplied by the diagonal percent of 1.118. The result is 8'-$10\frac{1}{8}$". Add this to the overhang diagonal of 2'-$1\frac{1}{8}$" (same as common rafter overhang), and we get a jack rafter length of 10'-$11\frac{1}{4}$". Note that because the connection angle is 45°, the measurement should be taken to the center of your cheek cut.

Finding a Ridge End Common Rafter Length—Example 3 on Roof Example Illustration

As long as you use the top cut illustration in "Connection # 1," then this rafter will be cut the same length as the king common rafter adjacent to it.

Finding a Hip Length—Example 4 on Roof Example Illustration

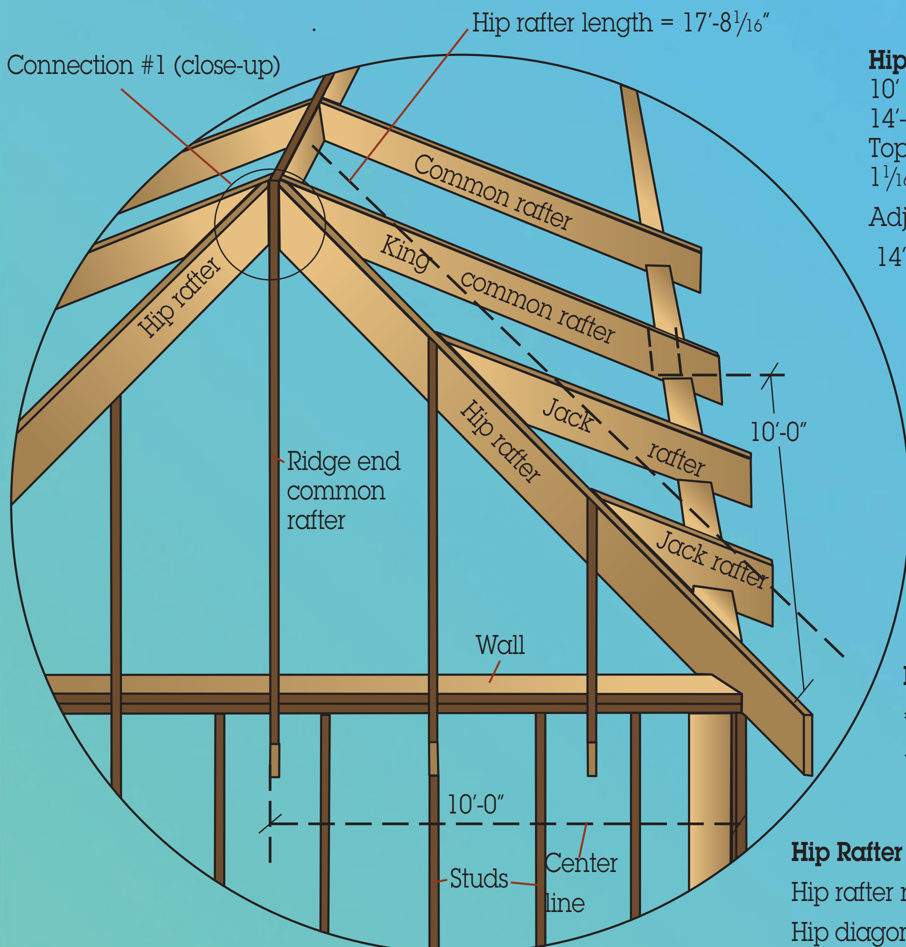
Finding the hip length requires an additional step and uses the hip-val diagonal percent. First find the hip run. It is the diagonal created by a triangle in which the other two sides are the run of the ridge end common and the line from the hip corner to the ridge end common. In this case, the span is 40', so the run is 20', and the distance from the corner is also 20'. Using the calculator, enter 20' for the run, 20' for the rise, and press the diagonal button. The result is 28'- $3\frac{7}{16}$". This distance is the run of your hip.

Subtract half the distance of the ridge at a 45° angle, which for a $1\frac{1}{2}$" ridge is $1\frac{1}{16}$", leaving an adjusted hip run of 28'- $2\frac{3}{8}$". Then find the hip overhang length using a similar procedure. The sides are 2', which leads to a 2'-$9\frac{15}{16}$" diagonal. Then subtract $1\frac{1}{2}$" at a 45° angle for the fascia (which is $2\frac{1}{8}$"), so the hip overhang run is 2'-$7\frac{13}{16}$". Add this figure to the 28'- $2\frac{3}{8}$" hip run, and you get a hip rafter run of 30'-$10\frac{3}{16}$". Multiplying that number by the hip-val diagonal percent of 1.061 results in a hip rafter length of 32'-$8\frac{3}{4}$". Remember, these lengths are to the middle of the rafter, and each end has two 45° connection angle cuts at a 6/12 hip-val pitch angle.

Finding a Valley Rafter Length—Example 5 on Roof Example Illustration

This valley will be the same length as the hip rafter for the 28'-0" span section, except for the end cuts. On the bottom, the 45° cuts will be concave (<) instead of convex (>) like the hip. At the top, there will be a full-width 45° cut. The top-end adjustment will require you to subtract one half the thickness of the ridge at 45°, which is $1\frac{1}{16}$".

Connection # 1



Hip Run

10′ common run +10′ common layout = $14'\text{-}1\frac{11}{16}''$ unadjusted hip run

Top adjustment = – ½ of ridge at 45° = $1\frac{1}{16}''$ (for 2 × ridge)

Adjusted hip run = $14'\text{-}\frac{11}{16}'' - 1\frac{1}{16}''$= $14'\text{-}\frac{5}{8}''$

Overhang Run

2′ common run & 2′ common layout = $2'\text{-}9\ \frac{15}{16}''$ unadjusted overhang run

Bottom adjustment = ½ of fascia at 45°

For 2 × fascia = $2\frac{1}{8}''$

Ajusted overhang run = $2'\text{-}9\frac{15}{16}''$ $-2\frac{1}{8}''$ = $2'\text{-}7\frac{13}{16}''$ overhang runc

Hip Rafter Run

= Hip run + overhang run = $14'\text{-}\frac{5}{8}''$ + $2'\text{-}7\frac{13}{16}''$ = $16'\text{-}8\frac{7}{8}''$

Hip Rafter Length

Hip rafter run ($16'\text{-}8\frac{7}{8}''$) × 1.061 = $17'\text{-}8\frac{11}{16}''$

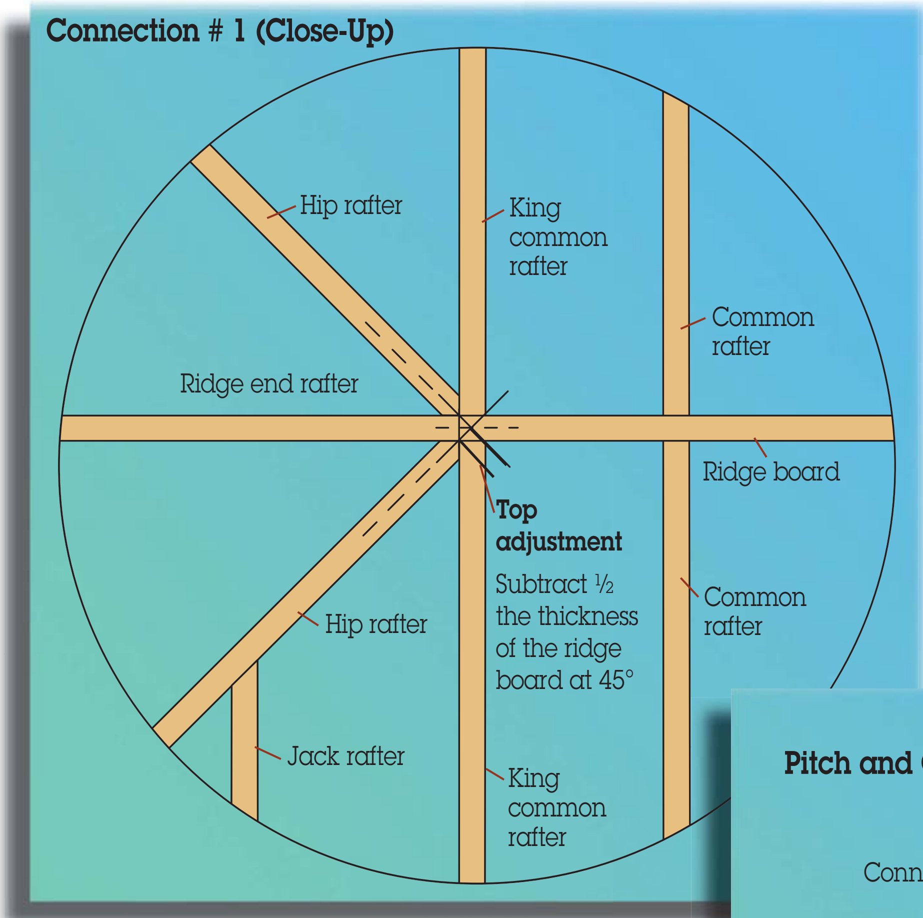
Hip diagonal percent from Diagonal Percent Chart.

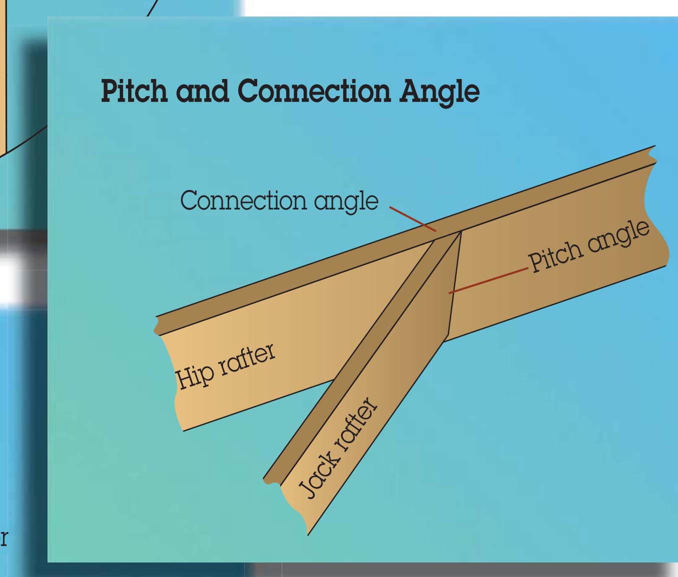
Adjust length for hip rafter before finding hip rafter length.

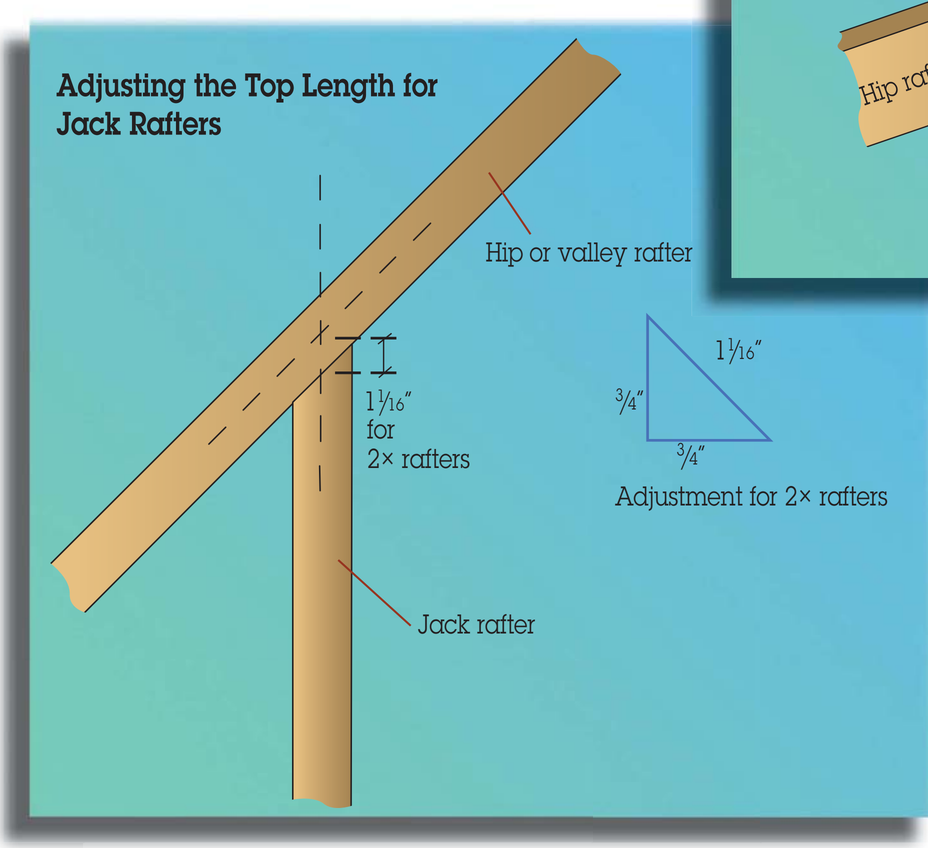
Framer-Friendly Tips

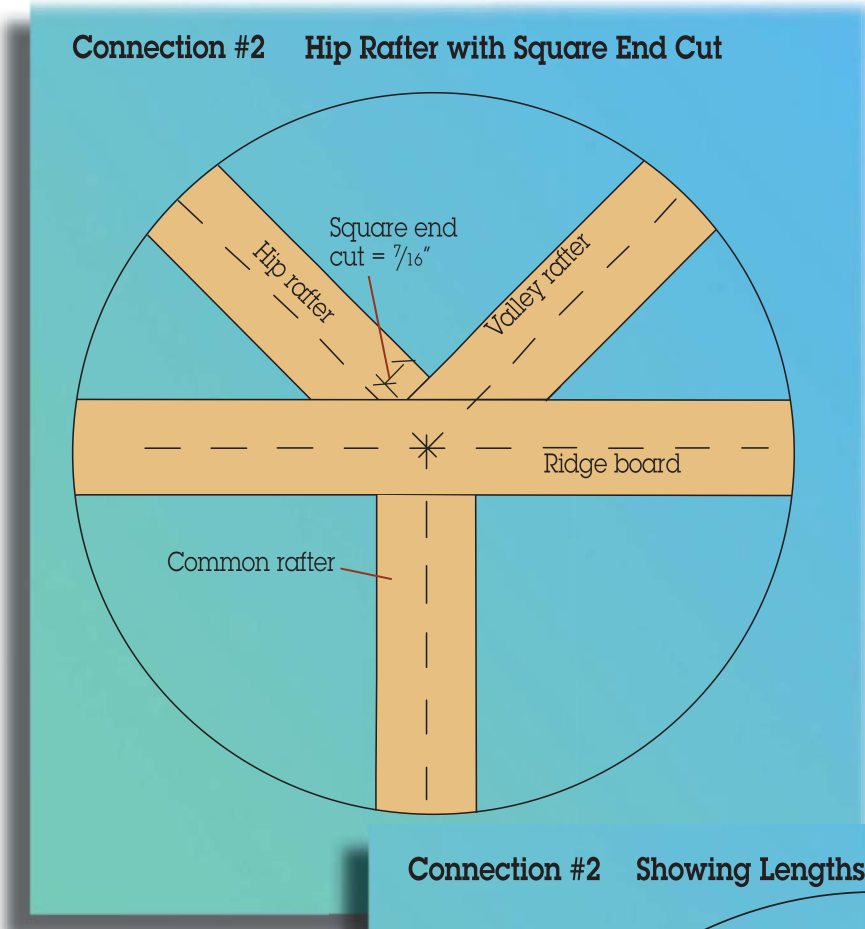
When using I-joist rafters, the cut bottom flange must rest entirely on the wall.

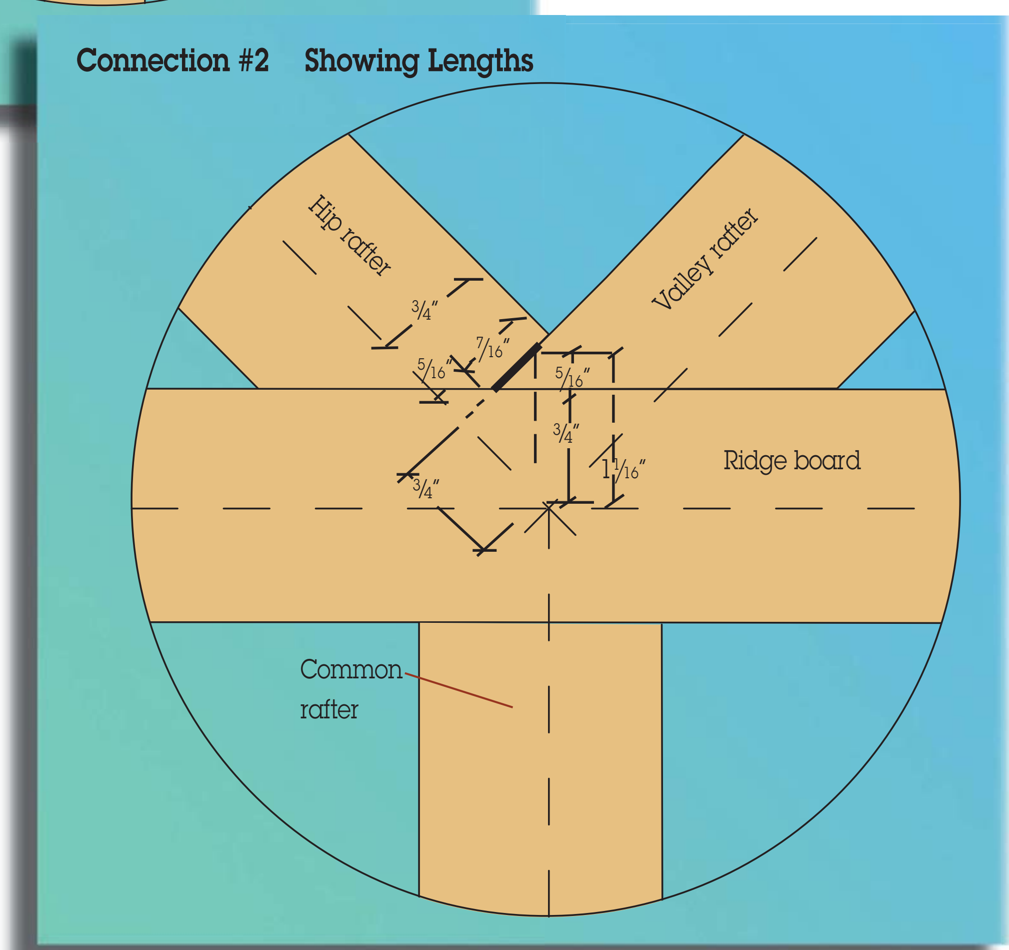
Connection #1 is the intersection of the ridge board, three common rafters and and two hip rafters. The dashed lines represent the (theoretical) framing point.








Connection #2 Hip Rafter with Square End Cut
Square end cut = 7/16″
Hip rafter
Valley rafter
Ridge board
Common rafter


Connection #2 Showing Lengths
Hip rafter
Valley rafter
3/4″
7/16″
5/16″
5/16″
3/4″
1 1/16″
3/4″
Ridge board
Common rafter

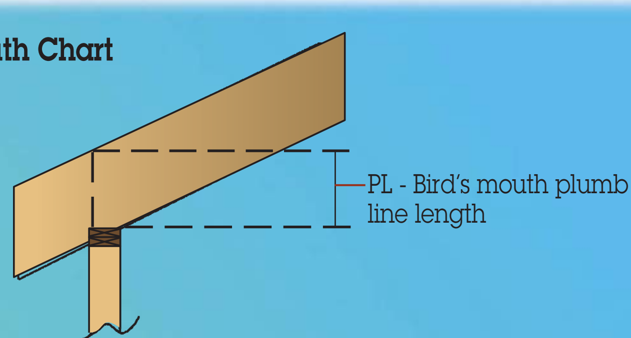
Finding the valley rafter length is similar to finding the hip length, and requires the following steps:

- Span = 28'-0"
- Run = 14'-0"
- Top adjustment = subtract ½ ridge board at 45° = 1 1/16".
- Hip run = 19'-9 9/16" = On the calculator enter 14'-0".
  – Then press the *run* button, enter 14'-0".
  – Then press the *rise* button and then the *diagonal* button.
- Overhang hip run = 2'-7 13/16"
  – On calculator enter 1'-10 1/2" *run* then 1'-10 1/2" *rise*, then press *diagonal*.
- Add the hip run and the overhang hip run = 19'-9 9/16" + 2'-7 13/16" = 22'-5 3/8".
- Subtract for the top adjustment ¾" on a 45° = 1 1/16" (See "Connection #2" illustration on previous page.)
- Adjust the hip rafter run = 22'-5 3/8" – 1 1/16" = 22'-4 5/16".
- Hip rafter length = 22'-4 5/16" × 1.061 (hip-val diagonal percent) = 23'-8 11/16".

The top will be a 45° saw cut for the connection angle at a 6/12 hip-val cut for the pitch angle.

The bottom will be concave (<), two 45° saw cuts at a 6/12 hip-val cut.

Bird's Mouth Chart



Bird's Mouth Plumb Line Lengths

2 × 6 Walls

Rafter Size	11¼	9¼	7¼	5½
Pitch				
3/12	10¼	8 3/16	6⅛	4 5/16
4/12	10 1/16	7 15/16	5 13/16	4
5/12	9⅞	7 11/16	5 9/16	3 5/8
6/12	9 13/16	7 9/16	5 3/8	3 3/8
7/12	9 13/16	7½	5 3/16	3 3/16
8/12	9 13/16	7 9/16	5	2 15/16
9/12	9 15/16	7 9/16	4 15/16	2 3/4
10/12	10 1/16	7½	4 7/8	2 5/8
11/12	10 3/16	7½	4 3/4	2 3/8
12/12	10 7/16	7 9/16	4 3/4	2 1/4

2 × 4 Walls

Rafter Size	11¼	9¼	7¼	5½
Pitch				
3/12	10 ¾	8 11/16	6 5/8	4 13/16
4/12	10 11/16	8 9/16	6 7/16	4 5/8
5/12	10 ¾	8 9/16	6 7/16	4 ½
6/12	10 13/16	8 9/16	6 3/8	4 3/8
7/12	10 15/16	8 5/8	6 5/16	4 5/16
8/12	11 3/16	8 13/16	6 3/8	4 5/16
9/12	11 7/16	8 15/16	6 7/16	4 ¼
10/12	11 11/16	9 1/8	6 ½	4 ¼
11/12	12 1/16	9 5/16	6 5/8	4 ¼
12/12	12 7/16	9 9/16	6 3/4	4 ¼

Charts provide bird's mouth plumb line lengths.

Finding a Valley-to-Ridge Jack Rafter—Example 6 on Roof Example Illustration

There are a couple of ways to find the length of this rafter. The ridge location is easy to establish as half the span of 40', making it 20'. The valley point can be determined by figuring the distance the valley runs before the rafter starts. In this case, since the rafters all conveniently line up and run at 24" O.C., the easiest method is to count the rafter spaces from the other side of the roof. In this example, there are seven rafter spaces; therefore the run will be

14'. Subtract half the distance of the 45° bottom cut for the valley rafter (1 1/16"), and half the thickness of the ridge board (3/4"), and the run will be 13'-10 3/16". The rafter length will be 13'-10 3/16" × 1.118 (diagonal percent) resulting in a 15'-5 13/16" rafter length. The connection angle at the top will be a 90° saw cut, and the pitch will be at a 6/12 common cut on the speed square. The bottom will be a 45° saw cut at a 6/12 common cut. The measurement will be to the center of the 45° cheek cut.

Finding Valley-to-Hip Jack Rafter Length—Example 7 on Roof Example Illustration

There are different ways to find the run length. Here is a way that has not yet been illustrated. In this example, run length will be figured from the 28' span length. The run for the 28' span is 14'. The top of the rafter is 2' past the end of the ridge board, which will add 2' to the run going up the hip that it connects to.

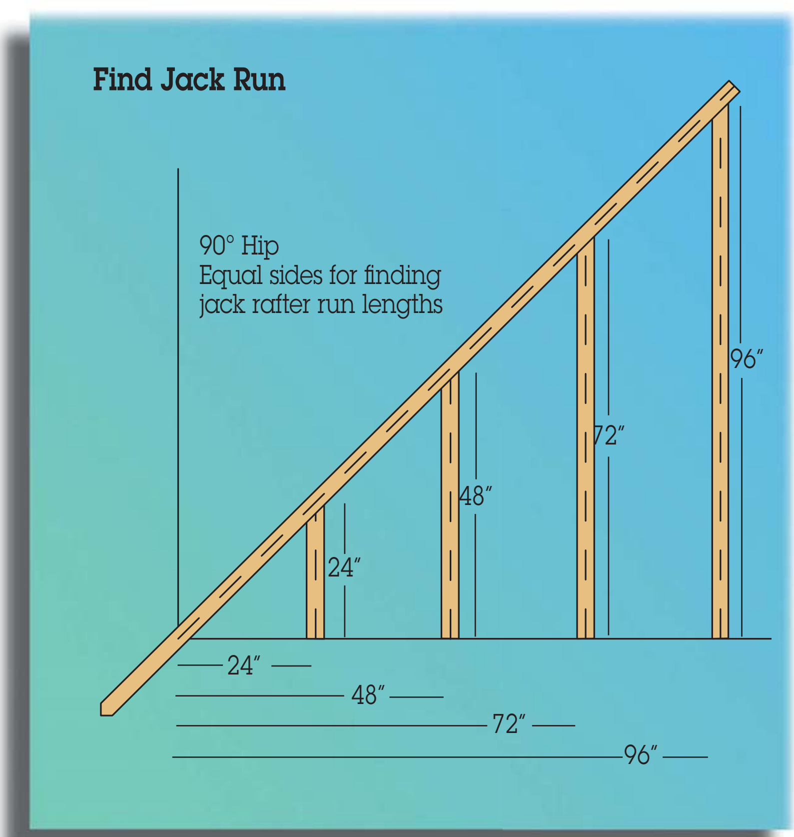
The run at the bottom will be shortened by 4' because it extends up the valley the equivalent of 4' of run. This leaves 12' of run. Adjust for top and bottom by subtracting one half of a 45° angle for top and bottom cuts or two times 1 1/16" (2 1/8") = 11'-9 7/8" times 1.118. This makes for a rafter length of 13'-2 5/8". Both the top and bottom would have a 45° cheek cut for the connection angle and would be marked at a common 6/12 for the pitch angle.

Ridge-to-Ridge Hip Rafter—Example 8 on Roof Example Illustration

In this example, the rafters are so conveniently arranged that we can see the hip rafter goes from the center of one rafter to the center of another rafter with two in between, resulting in a distance of 6'.

Another way to find this length is to calculate the difference in the runs for the ridges that establish the height difference. One has a span of 28'-0" for a run of 14'-0", while the other has a span of 40'-0" for a run of 20'-0". The difference is 6'-0", the same as we just figured.

Once you have the 6'-0" of run, then you follow the same procedure as with a hip and make the necessary top and bottom adjustments. First establish the hip run. Enter 6'-0" run and 6'-0" rise on the calculator and press diagonal, which gives you the hip run of 8'-5 13/16". The top will be a standard hip connection. Therefore one half the ridge at a 45° angle (11/16") will be subtracted. At the bottom it will be a #2 connection. (Connection #2.) Therefore subtract one half the thickness of the ridge at a 45° angle, or 11/16". The



Jack rafter run lengths equal layout lengths.

bottom will also require a square cut 7/16" deep on the end. You can establish the thickness of this square cut by finding the diagonal for the triangle in which the other two sides are the same and created by the balance of the difference between half the distance of the ridge board at 45° and half the distance of the ridge board at 90°.

The $^{7}/_{16}$" square cut will not affect your hip run. This means that you can subtract the $1^{1}/_{16}$" and $1^{1}/_{16}$" to get an adjusted hip run of 8'-$3^{11}/_{16}$". Multiplying 8'-$3^{11}/_{16}$" × 1.061 (hip-val diagonal percent) gives you the ridge to ridge hip rafter length of 8'-$9^{3}/_{4}$". The top cut will be a regular hip cut with convex (>) 45° cuts at a 6/12 hip-val pitch. The bottom will be a 45° cut at a 6/12 hip-val pitch with a $^{7}/_{16}$" square cut end.

Finding the Ridge Board Length—Example 9 on Roof Example Illustration

The ridge board runs parallel with the wall at the other end of valley #5 and the hip of the 28'-0" span. That length is 12'-0", so the length of the ridge is 12'-0" with adjustments at the ends. The hip connection is a number 1, so one half of the thickness of the common rafter ($^{3}/_{4}$") is added. At the other end, it is a connection #2, and the ridge will extend to the next rafter, adding $23^{1}/_{4}$" to the length.

The ridge board length therefore is: 12'-0" + ¾" + $23^{1}/_{4}$" = 14'-0". Both ends will be cut at 90° with square ends.

Summary

Until you have framed many roofs, cutting rafters is always going to be a challenge. Three ways to make it easier are:

- First, use the diagonal percent to find the rafter length.
- Second, figure lengths to the framing points and then make the adjustments.
- Third, become familiar with and use a construction calculator for the math.

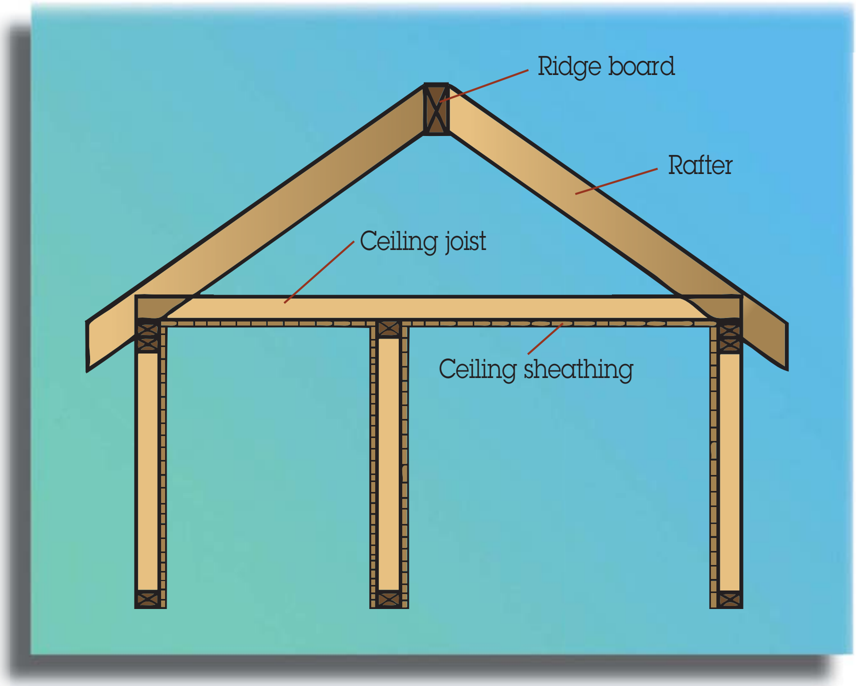
If ever you get stumped, you can always organize your thinking by using the four basic characteristics of cutting rafters:

1. Find the length.
2. Adjust for the top and bottom.
3. Figure the angle cuts for the top, bottom, and bird's mouth.
4. Figure the height of the bird's mouth.

Framer-Friendly Tips

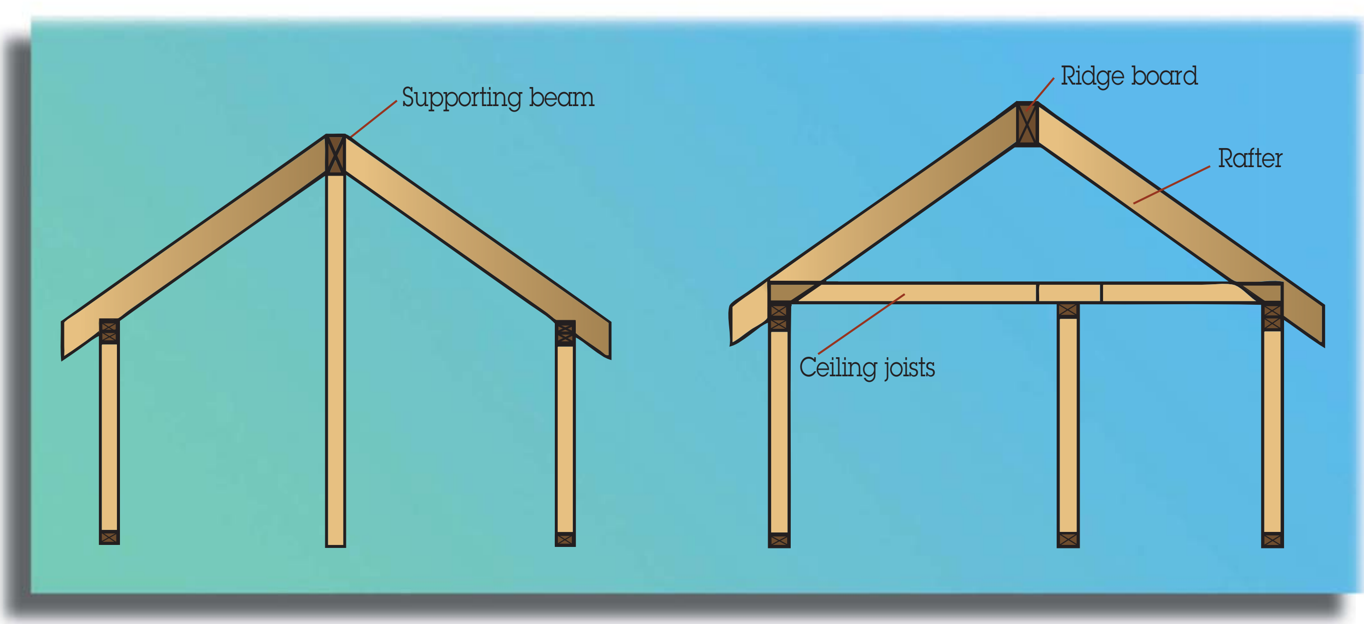
Sketching up what is unclear on a scrap piece of paper can help you to understand the connection better.

Ceiling Joists



Ceiling joists serve two basic functions: they provide support for the ceiling sheathing and the support needed to keep the rafters from pushing the walls out.

Rafters that are not supported at the top or somewhere along the span by a beam create an outward force on the wall they rest on. This force is frequently offset by ceiling joists joining the walls on the opposite side of the roof.



Ceiling Joists *(continued)*

The chart below shows a common size of ceiling joist needed for different spans.

Ceiling Joist Span Chart

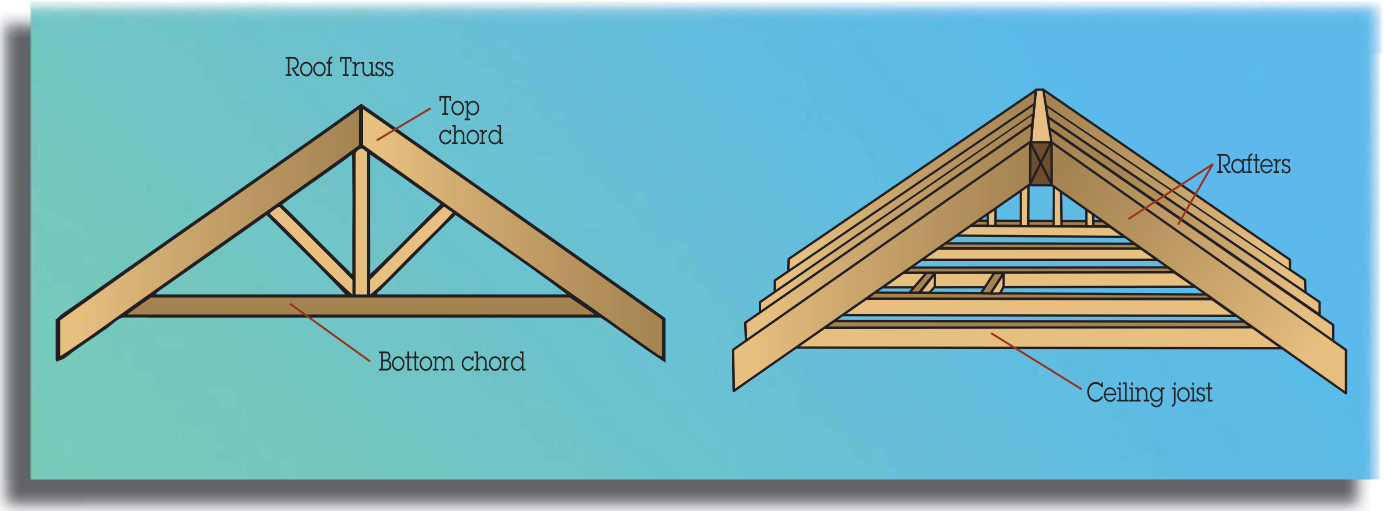
24" O.C. 20 PSF uninhabitable

Species & Grade	**Maximum Ceiling Joist Spans**		
	2 × 4	2 × 6	2 × 8
Douglas Fir-Larch # 1	7'-8"	11'-2"	14'-2"
Douglas Fir-Larch # 2	7'-2"	10'-6"	13'-3"
Douglas Fir-Larch # 3	5'-5"	7'-11"	10'-0"
Hem-Fir # 1	7'-6"	10'-11"	13'-10"
Hem-Fir # 2	7'-1"	10'-4"	13'-1"
Hem-Fir # 3	5'-5"	7'-11"	10'-0"
Southern Pine # 1	8'-0"	12'-6"	15'-10"
Southern Pine # 2	7'-8"	11'-0"	14'-2"
Southern Pine # 3	5'-9"	8'-6"	10'-10"
Spruce-Pine-Fir # 1	7'-2"	10'-6"	13'-3"
Spruce-Pine-Fir # 2	7'-2"	10'-6"	13'-3"
Spruce-Pine-Fir # 3	5'-5"	7'-11"	10'-0"

The previous chart shows a common size of ceiling joist needed for different spans.

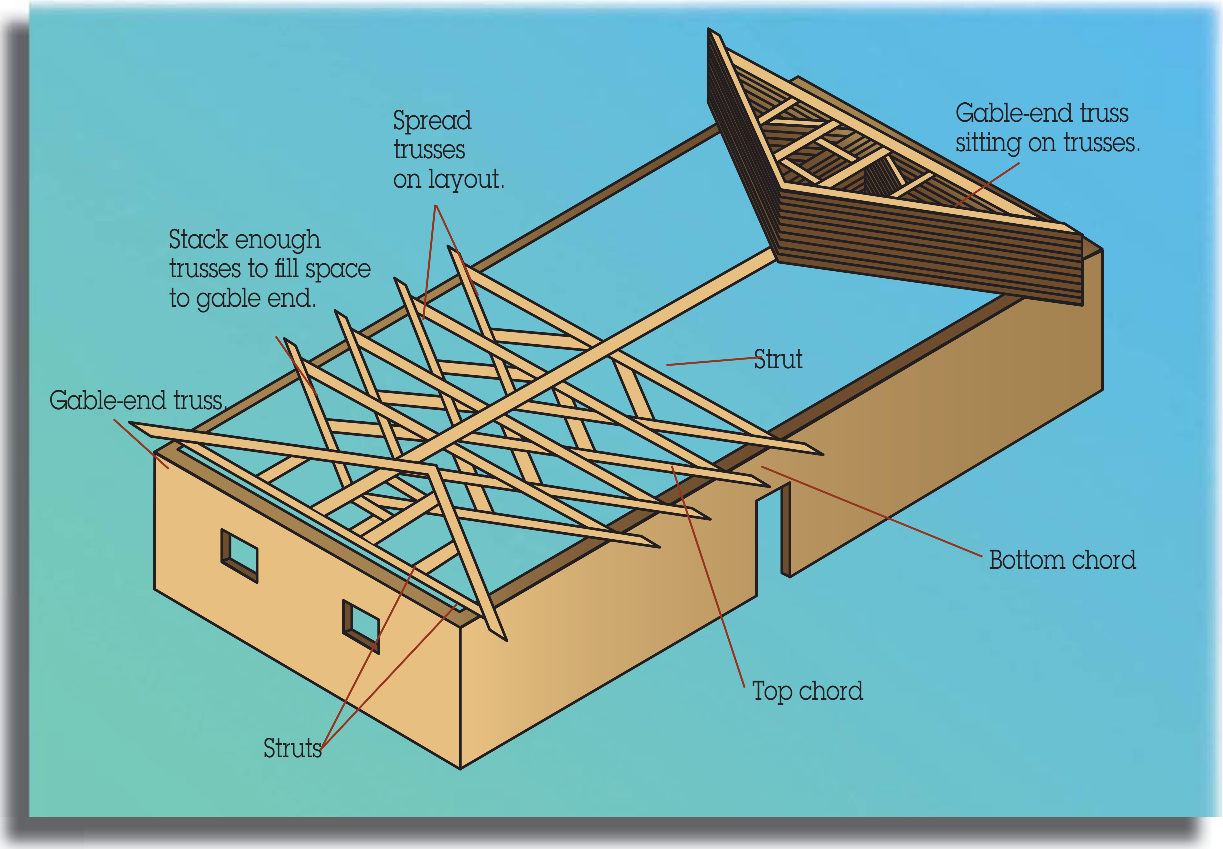
The bottom chord of roof trusses acts as a ceiling joist and provides support for the ceiling sheathing, and support to keep the walls from pushing out.

Attic areas above ceiling joists must be made accessible if there is a clear height of 30" or more. This requires framing an attic opening. The opening must not be less than 20" by 30" and have at least 30" clear space above. The attic access should be framed similar to an opening in floor joists as illustrated on "Step 5–Frame Openings in Joists" in Chapter 3.



Step 1–Spread Trusses

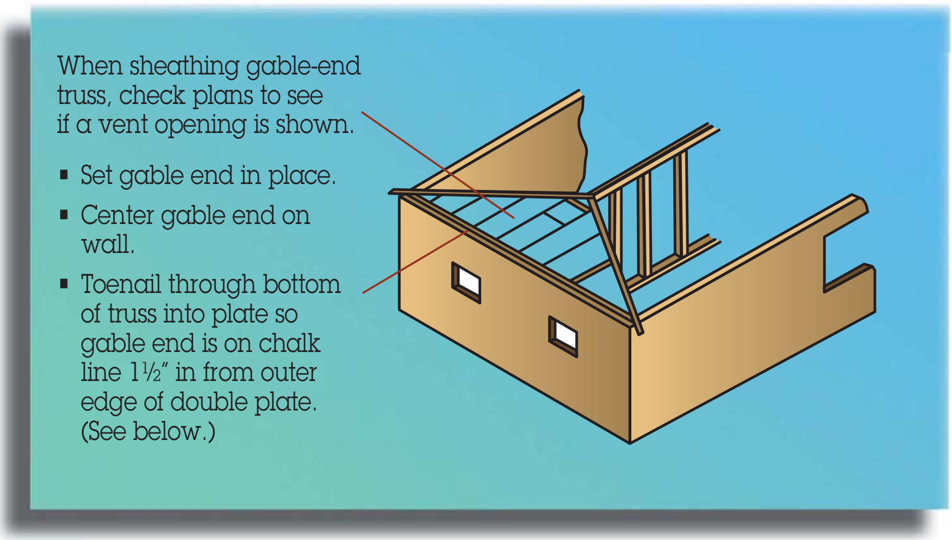
Trusses spread ready to roll



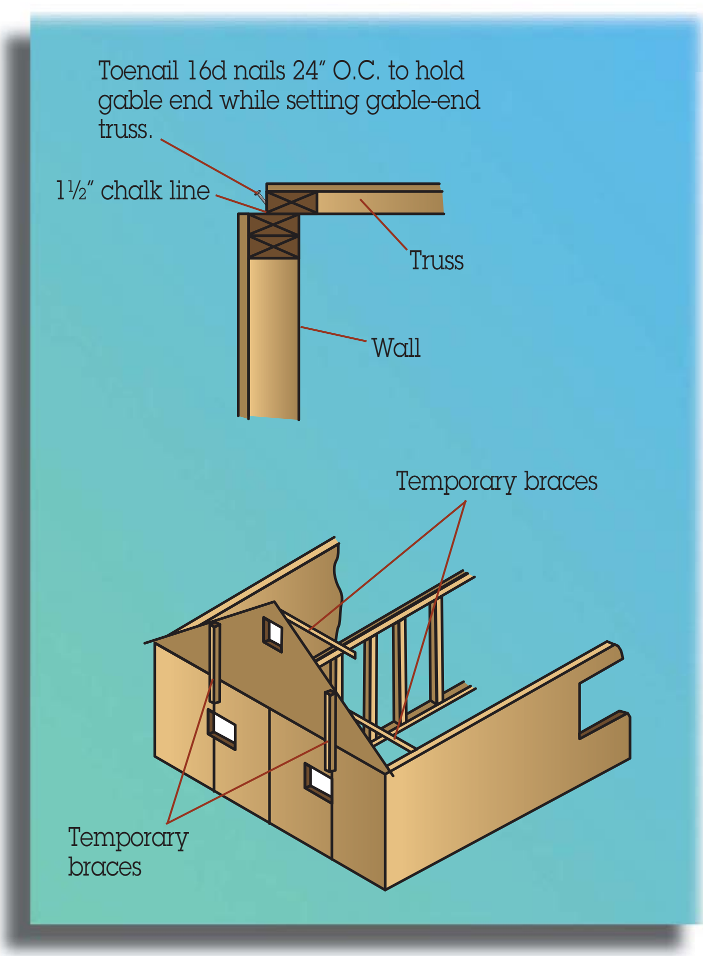
When trusses are delivered in stacks, they should be set on the roof to allow for easy spreading. The gable ends should be on top because they go up first. The direction of the ridge is important so they can be spread and tilted up easily.

When spreading the trusses, place them on your layout marks so that when you roll them, you will have minimum moving of the trusses. They are easier to move lying down.

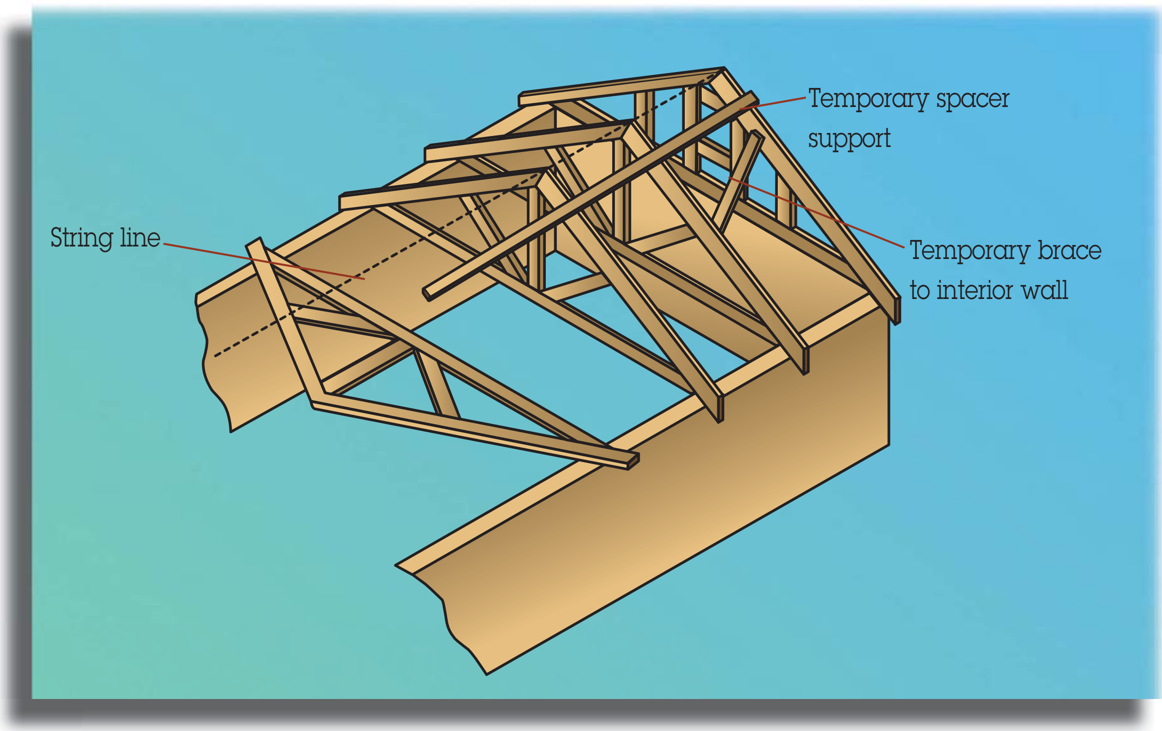
Step 2–Sheathe Gable Ends



Step 3–Set Gable Ends



Step 4–Roll Trusses



As each truss is raised, the temporary spacer/support is fastened to the truss.

Steps

1. String line from center of gable ends.
2. Lift single truss into place.
3. Center truss on string line.
4. Nail truss to exterior wall on layout.
5. Nail through temporary spacer support near ridge of truss and on layout marked on temporary spacer support.
6. Set six trusses. Then check gable end for plumb and put permanent brace on gable end. Permanent brace should connect top of gable end to an interior wall or a cross support running between the trusses.
7. Every eight trusses, add an additional brace. Refer to truss specifications for additional braces.

Rolling trusses into position

Steps 5–8

5. Block trusses

6. Lookouts
Lookouts support the roof overhang and fascia.

7. Fascia
The fascia defines the roof and provides a finish.

8. Sheathing
The skin for the roof, sheathing, is a structural part of the roof diaphragm.

Chapter Six
DOORS, WINDOWS & STAIRS

Contents

Door Framing Terms	116
Installation of Exterior Doors	116
Installation of Nail-Flange Window	119
Installation of Window Flashing	120
Installation of Sliding Glass Doors	121
Installation of Stairs	122
Circular Stairs	127

Chapter Six

DOORS, WINDOWS, & STAIRS

Doors and windows are two of the few finish items that framers sometimes handle. It is important that time and care are taken to ensure they are installed in a proper, professional manner. Put your framing hammer in the toolbox and use, instead, a lighter, smoother-faced trim hammer and a nail set.

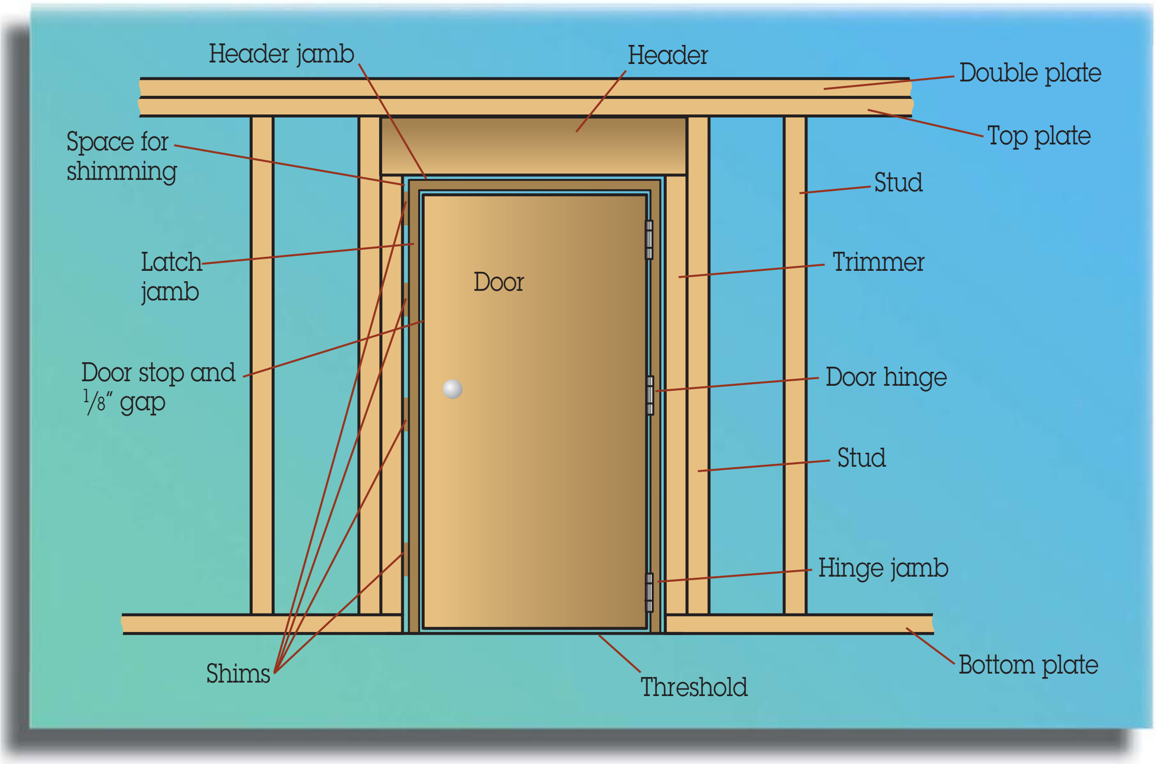
Exterior, pre-hung doors are the type covered in this chapter. They are the ones framers most commonly work with, and most of the skills involved in hanging them will carry over to the hanging of interior doors. The first door you hang on any job will give you the most difficulty. If you have more than one door to hang, do them one after the other; each door will go in a little easier than the one before.

Nail-flange windows and sliding glass doors will vary depending on the manufacturer. You will find here the basic principles of their installation. Use common sense and follow the directions provided, and you should have little trouble installing these units.

Stairs represent one of the more difficult challenges to a framer's skill. As in roof framing, the geometry is a bit complicated, but taken step-by-step, the logic soon becomes clear, leading to successful execution of the plans. There are many different stair designs. The stair layouts described in this chapter are typical. Be aware that the dimensions given on the plans do not always allow for enough headroom. Always check headroom and other dimensions by taking accurate on-site measurements. This chapter also contains instructions for laying out and framing circular stairs.

The instructions for installation of pre-hung doors, windows, sliding glass doors, straight stairs, and circular stairs are all presented in steps for easier understanding. A calculator is handy—some might say necessary—for finding the rise and tread dimensions when not given on the plans. Always double- or triple-check your calculations. Remember: measure twice, cut once. The finish floors at the top and bottom of stairs are often different. When cutting stair stringers, don't forget to check the plans for such differences and then check the height of your top and bottom risers to allow for them.

Door Framing Terms

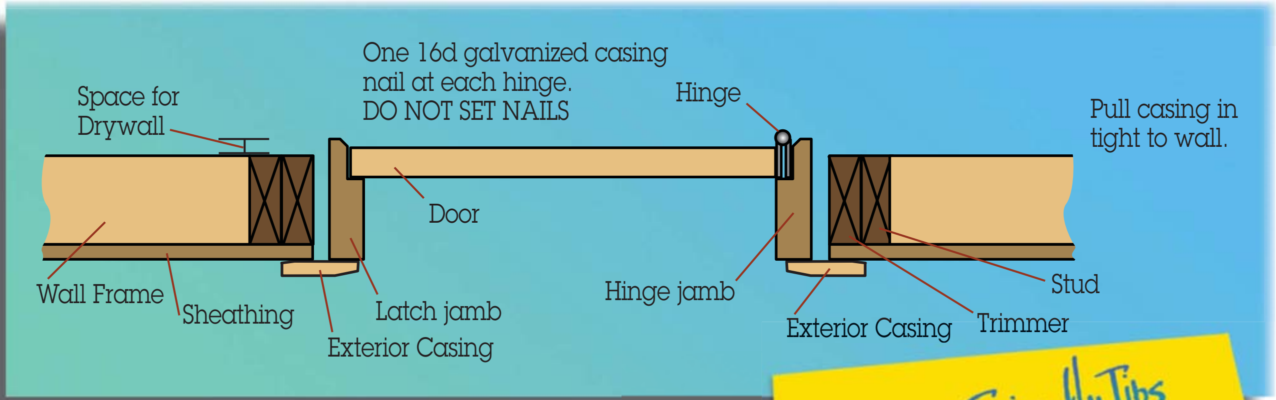


Installation of Exterior Doors

Steps for Pre-Hung Doors

1. Read instructions that come with door.
2. Check plans for door swing.
3. Check threshold for level.
4. Nail hinge jamb.
5. Nail latch jamb using shims.
6. Check door for overall fit.
7. Nail door.
8. Set nails and break or cut shims.
9. Check again for overall fit.

Installation of Exterior Doors *(Continued)*



View of door looking down from the top

Framer-Friendly Tips

Nail with caution to prevent marking jambs. Use a smooth face hammer in case you miss.

Steps for Installation

1. READ INSTRUCTIONS
   - Usually there are instructions that come with the door. Check the instructions over for anything you might need to know.
2. CHECK PLANS
   - Check the building plans to find the direction of the door swing.
3. CHECK THE THRESHOLD
   - Check the threshold for level. Shim under hinge jamb if necessary.
4. NAIL HINGE JAMB
   - Nail hinge jamb tight to trimmer with one 16d galvanized casing nail at each hinge. Do not set nails. Plumb both directions. Shim behind jamb if necessary to obtain plumb or if door needs to be centered in opening.

Framer-Friendly Tips

For a stronger connection remove one screw from each hinge and after replace it with a longer screw to go through the jamb, the shims, and into the stud-trimmer.

Installation of Exterior Doors *(Continued)*

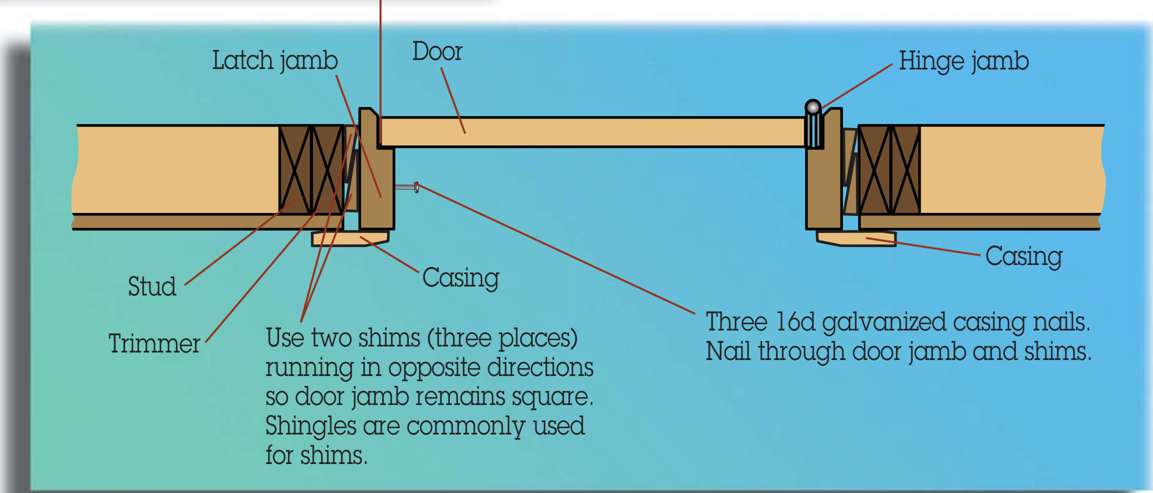
5. NAIL LATCH JAMB
   Before nailing the latch jamb, make sure:
   - There is a continuous gap between door and jamb of 1/8".
   - Door touches latch jamb equally at top and bottom.
   - Lockset hole in the door and latch jamb line up.

6. CHECK DOOR FOR OVERALL FIT:
   - Gap around door is even.
   - Door and latch jamb align.
   - Door closes smoothly, no binding.
   - Lockset holes line up.
   - Door closes tight, no rattle.

7. NAIL DOOR
   - Six 16d galvanized casing nails in hinge jamb—two at each hinge.
   - Four 16d galvanized casing nails in latch jamb—one each top and bottom and two near latch. This includes nails used in Steps 4 and 5.

8. SET NAILS AND TRIM SHIMS

9. FINAL CHECK
   - Check again for overall fit. (See Step 6.)



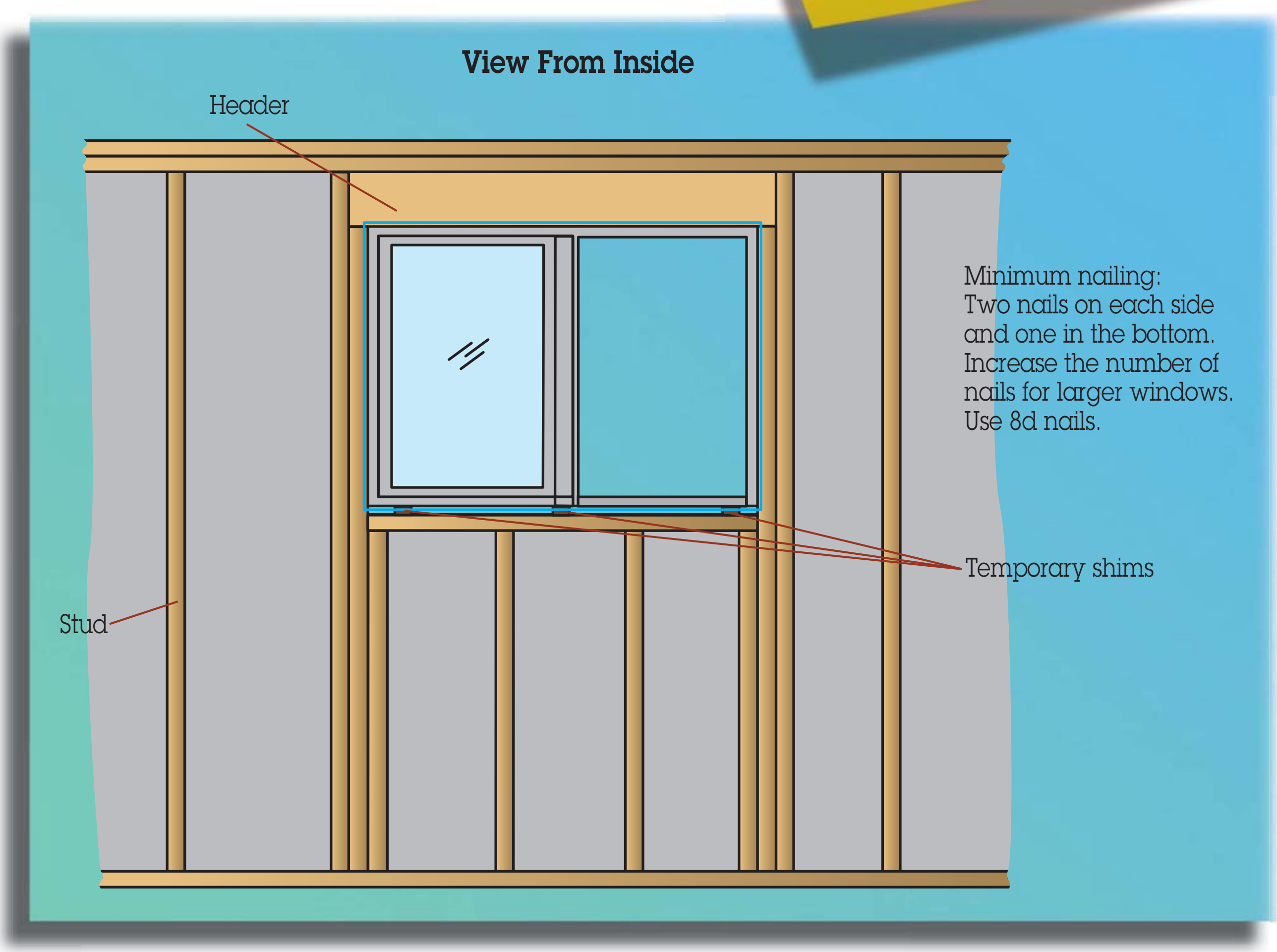
View of door looking down from the top

Installation of Nail-Flange Window

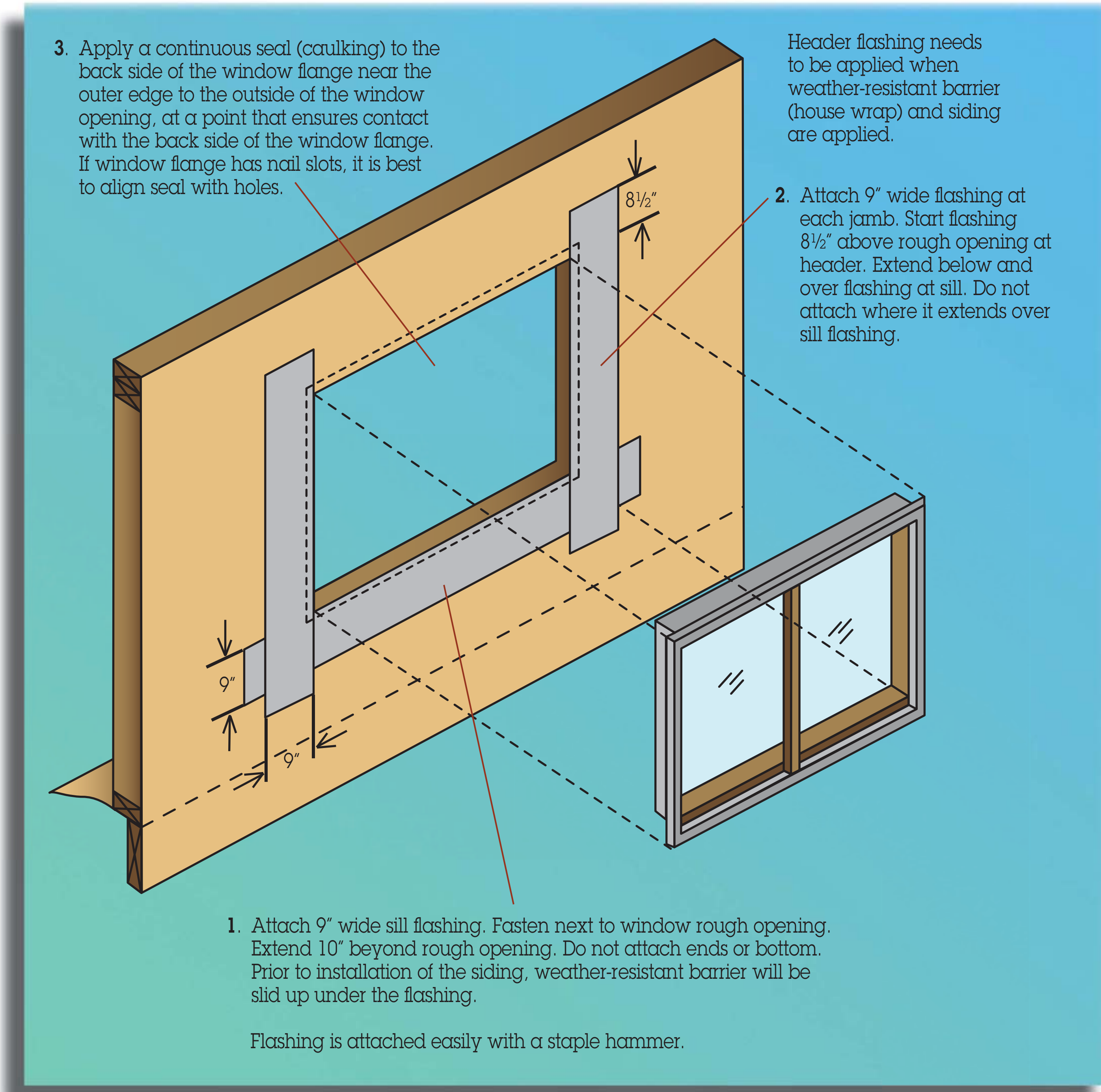
1. Install window flashing. (See the following section.)
2. Set window in place.
3. Place temporary shims under bottom of window. Equalize space at top and bottom of window. Shims are usually 1/8" to ¼". Level windowsill.
4. Make gaps the same between window frame and trimmer on each side.
5. Nail top corners from outside.
6. Nail one bottom corner. (Do not set all the way.)
7. Place window slider in and check to see if the gap between the window slider and window frame is the same from top to bottom.
8. If the gap is not equal, check both the rough opening and the window for square, and adjust accordingly.
9. Finish nailing. Make sure gap is equal top, bottom, and middle. (Do not nail top of the window.)

Framer-Friendly Tips

If you're using aluminum nail-flange windows, don't use galvanized nails. They will react chemically or corrode.



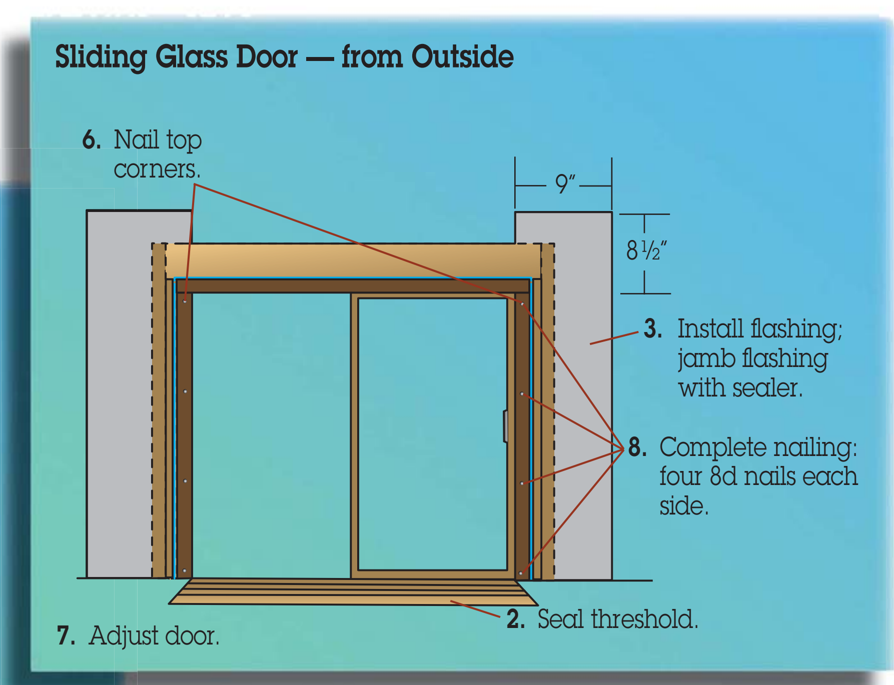
Installation of Window Flashing

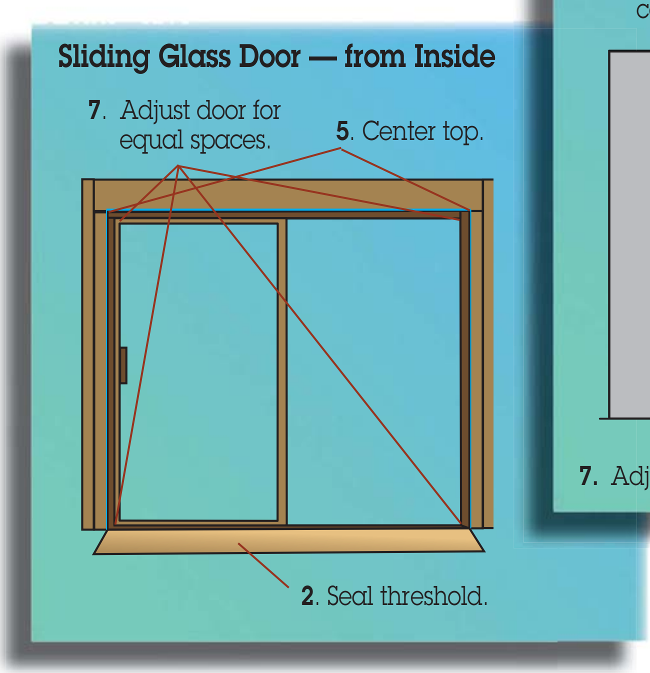


Moisture penetration in buildings can cause rot in the structure. New and more extensive exterior rain protective systems have been developed and used to combat this problem. Some of these systems use a special type of water resistant barrier and self-adhesive flashing. Another system is the rainscreen. It provides a whole second layer of protection, typically by installing furring strips over the initial water-resistive barrier and then an outside siding material attached to the furring strips. These furring strips allow for ventilation and pressure equalization. These systems have not been standardized yet and so it is important to follow the specifications as outlined on the plans.

Installation of Sliding Glass Doors

1. **READ INSTRUCTIONS.**
   Read and follow carefully the instructions that come with the door. Never assume what you do not know.
2. **SEAL THRESHOLD.**
   Use neoprene or similar sealing compound to seal the threshold.
3. **INSTALL FLASHING.**
   The jamb flashing with sealer is installed using a method similar to the jamb flashing on windows.
4. **PLACE DOOR.**
   Place the door in position.
5. **CENTER TOP.**
   Center the top of the door in rough opening.
6. **NAIL TOP CORNERS.**
   Nail each corner of the top of the door through nail flange. (Do not set nails.)
7. **ADJUST DOOR.**
   Adjust the door frame so that the space between the door frame and wall trimmers is equal. Check for plumb with a level and adjust if necessary.
8. **COMPLETE NAILING.**
   Close the door and latch it. Then nail off the sides using four 8d nails on each side. Do not nail top of door.
9. **ADJUST DOOR.**
   Adjust the slider part of the door if necessary. Usually there is an adjustment screw at the bottom of the door. Tighten this screw to close a gap between the door and the jamb at the top of the door, or loosen to increase the gap.
10. **TIGHTEN SCREWS.**
    If screws come with the door, shim and tighten screws in the sides and bottom. Use pre-drilled holes.





Installation of Stairs

The three main dimensions in stair building are for risers, treads, and headroom. The riser height and the tread width are usually given on the plans. You can generally use the tread width given on the plans. The riser height, however, is often not accurate enough to use.

Stair Installation Steps

1. MEASURE HEIGHT.
   Measure the height of the stairwell from finish floor to finish floor.
2. FIND RISER HEIGHT.
   Divide the height of the stairwell by the number of risers shown on the plan to determine the riser height. Be careful to consider the finish floor heights, which may differ top and bottom.
3. FIND TREAD WIDTH.
   Check plans for tread width.
4. CHECK HEADROOM.
   Chalk a line from edge of nosing at top of stairs to edge of nosing at bottom of stairs. (See “Checking Stair Headroom” later in this chapter.) Check for minimum clearance of 6'-8" to finish straight up from line to bottom of headroom.
5. MARK AND CUT STRINGERS.
   (See “Marking Stair Stringers” later in this chapter.”)
6. CUT.
   Cut stringer spacers, treads, and risers.
7. NAIL STRINGER SPACER.
   Nail stringer spacer to stringer. Spacer leaves clearance for applying wall finish.
8. SET STRINGERS.
   a. At top deck, measure down riser height plus tread thickness and mark for top of stringer.
   b. Set stringers to mark.
   c. Check stringers for level by placing a tread on top and bottom and checking level, side to side, and front to back.
   d. Adjust stringers for level.
   e. Nail stringers.
9. NAIL RISERS.
10. GLUE AND NAIL TREADS.

Finding Riser & Tread Dimensions

If the riser and tread dimensions are not given on the plans, then you need to calculate them. To do this you should consider the following points:

- You want the steps to feel comfortable.
  - When walking up steps, a person's mind determines the height of the riser based on the first step. Make sure all risers and treads are equal, so the stairs will not cause people to fall.
  - The lower the riser, the longer the tread needs to be to feel comfortable.
- Common dimensions for riser and tread are 7" rise and 10½" tread.
- Use the following three rules to check to see if your stair dimensions are in the comfortable range.
  - Rule 1: Two risers and one tread added should equal 24" to 25".
  - Rule 2: One riser and one tread added should equal 17" to 18".
  - Rule 3: Multiply one riser by one tread and the result should equal 71" to 75".

Important Stair Code Regulations

The following guidelines for stairs are according to the 2006 *International Residential Code* (IRC) and 2006 *International Building Code* (IBC)

Width – 36" minimum – with occupant load of 49 or less (measured in clear, to finish).

44" minimum – with occupant load of 50 or more (measured in clear, to finish).

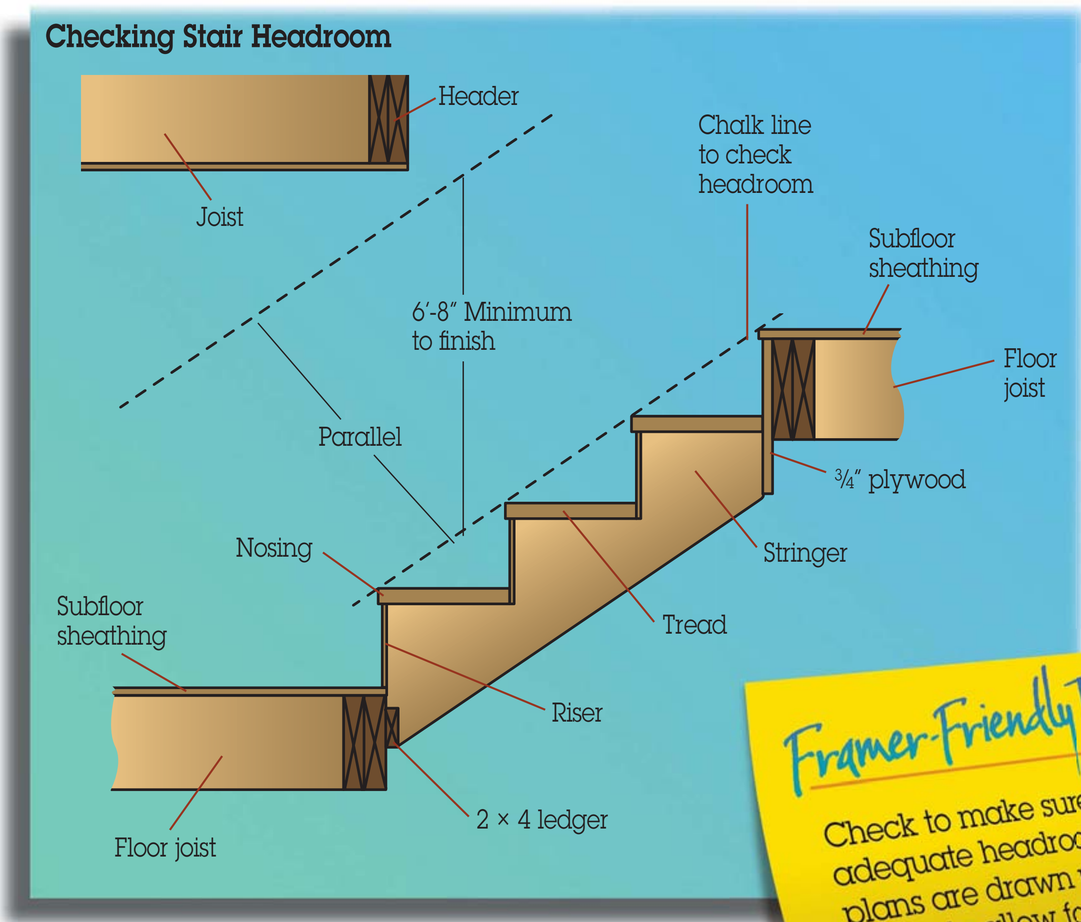
Rise – 4" minimum.

7¾" maximum for IRC – 7" for IBC, with residential 7¾".

Tread – 10" minimum for IRC – 11" for IBC.

Riser height and tread length variance – 3/8" maximum variation between the treads within any flight of stairs.

Headroom – 6'-8" minimum, measured vertically from a line created by connecting the nosing of the stair treads to the soffit above.



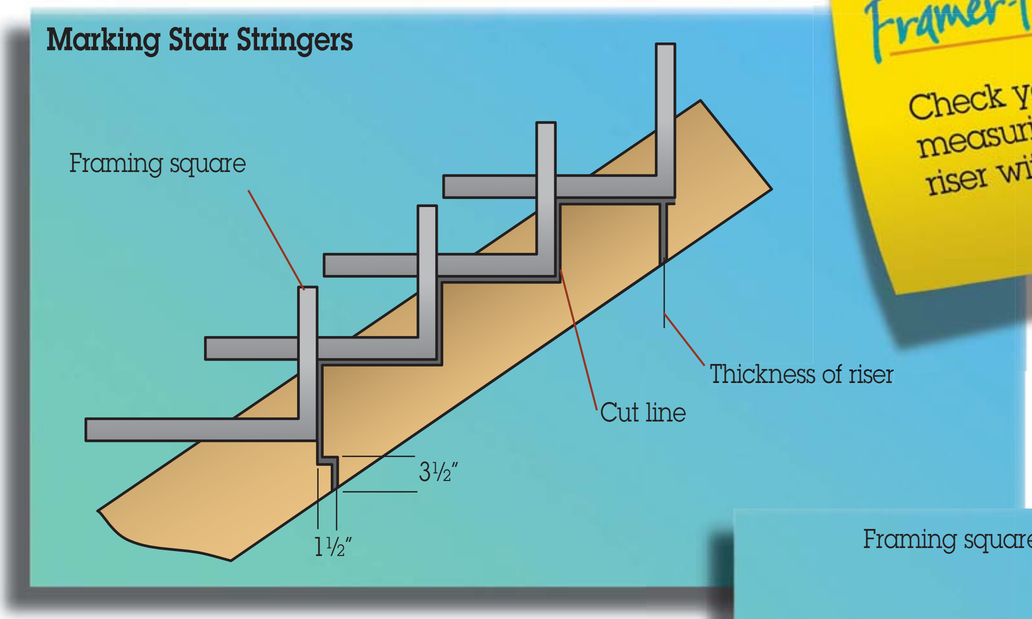
Framer-Friendly Tips

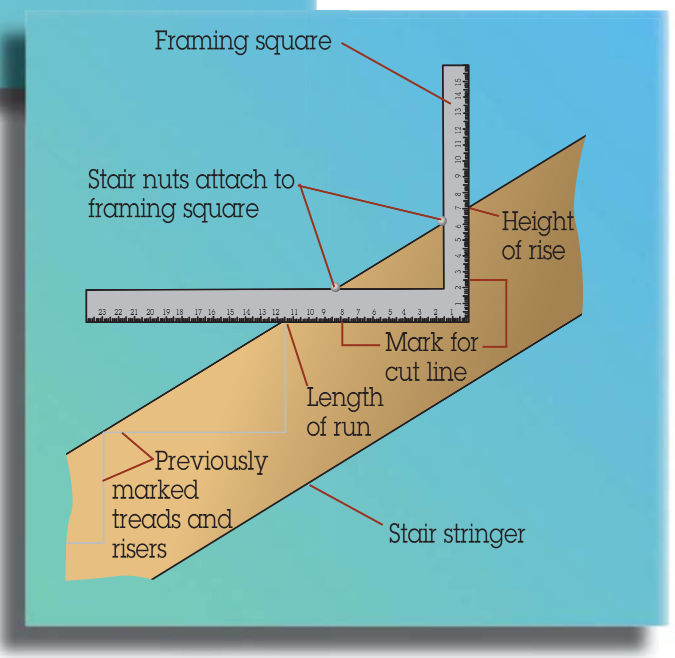
Check to make sure there is adequate headroom. Sometimes plans are drawn up that do not properly allow for this.

Before Stairs Are Built...

Check for headroom by finding the distance vertically between two lines that represent the distance between the stair treads and any obstruction in the headroom. One line is a straight line that connects the nosing on the stairs. The second line is one that runs parallel with the first line but 6'-8" in a vertical direction above the first line.

To create the stair noising line, first measure up the height of one riser and back from the riser the distance of the noising and make a mark. From that mark, measure parallel to the subfloor a distance equal to the combined width of the number of treads. Then measure perpendicular to the subfloor the combined height of the number of risers and make a second mark. Chalk a line between these two marks. From this line, make the second line that is parallel and yet a minimum of 6'-8" vertically. This is your headroom and if anything protrudes into this space you do not have minimum headroom. Remember this distance is to the finish, and so if you are putting carpet or drywall on then you need to allow for their thickness.





Framer-Friendly Tips

Check yourself by measuring each tread and riser with your tape.

Marking Stair Stringers

1. Measure treads and risers using framing square.
2. Subtract thickness of riser from top.
3. Notch bottom for ledger or top plate. Notches differ. (See illustrations in this and following section.)
4. Care must be taken when marking the top and bottom steps. The thickness of the stair tread and the type of finish flooring on both the tread and the floor must be considered so that all the risers will be the same.
5. For the top tread, be sure to figure in the riser so that the treads and nosings are all equal.

Framer-Friendly Tips

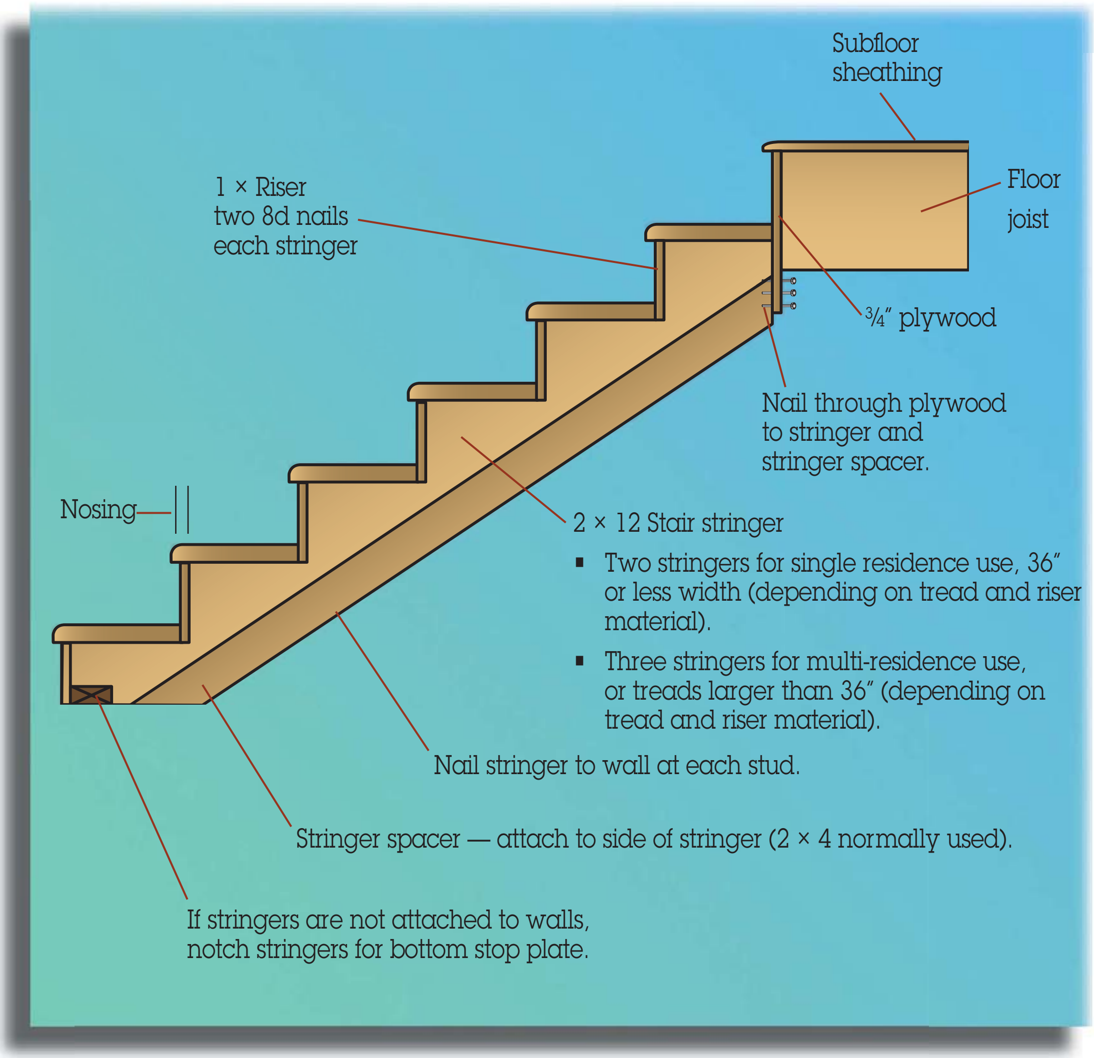
One of the most common mistakes is not adjusting top and bottom riser height for floor coverings.

Standard Stair (to be carpeted)

Adapt these guidelines for use when plans do not give details.

2 × 12 Stair tread:

1. Router nosing with ½" round router bit.
2. Glue and nail three 16d nails on each stringer for single residence use.
3. Glue and nail four 16d nails on each stringer for multi-residence use.



Recap of Key Stair Guidelines

The following are important items to go over to make sure you end up with a good set of stairs:

- Check the code maximum and minimum widths, depths, and heights.
- Remember to review the floor finish on the top, the bottom, and any midway decks for different thickness in the finish floor material. For example, if there is going to be lightweight concrete on the floor sheathing, or if a carpet stair ends on a concrete slab, then the last tread height would have to be adjusted. It is important to stay within the 3/8" height variance (specified in the codes) between all the risers.
- If you have a midway deck in the stairs, make sure you check the height. Figure the height and measure from the top or bottom of the stairs, and then check by figuring the height and measuring from the opposite of top or bottom. If you figured right, your marks should align.
- It is not uncommon for a set of plans to be drawn up with the stair headroom less than the 6'–8" that the code requires. To check the headroom before you frame the stairs, you need to find the point that is plumb, down from the lowest point above the stairs, and then measure to the line in a plane with the nosing of your stair treads.
- Since the stairs are not built yet, the hardest part is finding that nosing plane. You can either work off the plans, if framing has not started, or work with the framing if the frame is ready for the stairs. To find this plumb point on the nosing plane, start from the first nosing, count the number of risers, and multiply that number by the riser height; then add the partial riser.
- To get the partial riser height, you just multiply the partial tread length by the riser percent, which is the riser height, divided by the tread length. Once you have found this length, you can measure either up or down, depending on which direction you used, to see if you have enough headroom.

Circular Stairs

Circular stairs are not as difficult as they seem the first time you think about doing them. They do, however, take some planning and careful work. There is no one way that curved stairs need to be built, as long as they are strong enough to bear the traffic. The method that follows is commonly used.

First of all, unlike straight stairs, we will not use stringers. Instead, each tread will be supported independently, by either a wall or a header. The header method allows for space to be usable under the stairs. The system outlined here uses a header to create what are called *tread walls*.

8 Steps for Building Circular Stairs

1) Find Riser Height

To get started, you first need to find your riser height. Quite often it is given on the plans, in which case you want to check it to make sure it works with the actual floor heights. If the height is not given on the plans, consider the following points when figuring the riser height.

- As with straight stairs, you want the steps to feel comfortable, so remember:
  — Make sure all risers are equal, so the stairs will not cause people to trip and fall.

Drawing the circumference lines

— The lower the riser, the longer the tread needs to be to feel comfortable.

- Common dimensions for riser and tread on straight stairs are 7" for the riser, and 10½" for the tread.
- For circular stairs, the tread width varies, so it is more difficult to figure the riser and tread dimensions.
- The comfortable range for circular stairs is harder to determine than the range for straight stairs because of the varying tread width. The code for residential buildings requires a minimum of 6" at the narrow end and 11" at a point 12" out from the narrow end. For other buildings, the code requires a minimum of 10" at the narrow end and 11" at a point 12" out from the narrow end. Because most of the length of the tread is greater than 11", the rise will typically feel more comfortable if it is less than it would be for a comparable straight stair.

2) Mark the Circumference Lines

With the rise figured out and the number of treads known, you can start marking your circumference lines. The best way to start is by making the stair footprint on the floor in the position where the stairs are going to be built. If the plans show a radius dimension and location, then you can use the plans to locate the radius center point. To make your circumference lines (which represent your stairs and the walls on the sides of the stairs), set a nail part-way at the located radius center point. Then hook your tape to the nail and mark your circumference lines by swinging your tape around the nail and holding your pencil on the required dimension. (See photo.) Most tape measures have a slot in the hooking end for a nail head. (See illustration later in this section.)

If the radius or the radius center point is not given, you will need to find it. You can vary the radius length, but make sure you can maintain the following four requirements:

- 6" minimum tread width at the narrow end of the tread (10" in non-residential).
- 11" tread width at a point 12" in from the narrow end.
- A minimum stair width of 36" in the clear to finish.
- In non-residential buildings, the smaller radius should not be less than twice the width of the stairway.

Framer-Friendly Tips

It's a challenge to hold your pencil on the tape while marking. It's easy to draw a second line to check your accuracy.

End of tape hooked to a partially set nail

The first thing you need to do to find your radius is to establish two points on the circumference opposite each other. They can be any two points. Look on the plans for points that are already established. If there are no established points, then select points that fit with the location of the stairs. Once you have established two points, it is merely a matter of bisecting the line between these points, finding the radius origin, and drawing your circumference lines from the radius origin. (See the "Bisecting a Line to Establish the Radius Origin" illustration.)

3) Marking the Tread on the Footprint

Now that you have your circumference lines, you need your tread lines. Since you have figured your riser height, you know the number of treads that you will have. Knowing the number of treads, you can find the exact tread point along your stair circumference. To do this, divide the stair circumference in half, and then divide those halves in half again and again until you are down to single treads. (See "Divide Circumference for Treads" illustration.)

If your stair has an uneven number of treads, then you have to subtract one tread before you begin dividing into halves. To subtract one tread, you first have to know the width. The width will be equal to the total stair circumference length divided by the number of treads.

It is difficult to measure the stair circumference, and so your one tread will probably not be exact. Therefore, when you are done marking all the other treads, re-mark the tread you measured first.

Once you have all your division points for the treads, then chalk lines from the radius center point through the division points to the longest circumference line, and those lines will make your tread footprint. (See "Tread Footprint" illustration.)

4) Cut Bottom Plate

The bottom plate of the tread walls will not be parallel to the top plate, as it would be in a straight stair. The bottom plate will follow the circumference and serve as the bottom plate for all the tread walls. A good way to make the bottom plate is to use two pieces of ¾" plywood. If the radius is not too small, you can cut the plywood with a circular saw. To mark on the plywood, set a nail anywhere and mark the plywood with a pencil and a tape measure. Use the dimensions from the stair footprint to get the radius length.

5) Nail Bottom Plate in Place

To build the stairs, start by nailing the bottom plates in place. (See "Bottom Plate Nailed in Place" illustration.)

6) Build the Tread Walls

The walls supporting the treads will be built as header walls. Built this way, they will provide the riser and allow space for storage below the stairs. The wall will consist of a 2 × 12 single header that will serve as the riser, a top plate, a double plate, trimmers for under the 2 × 12 header, and king studs next to the trimmer. A ledger to support the tread below will be nailed onto the header. (See "Section of Tread Wall from End" illustration.)

Each tread wall should be higher than the one below it by the riser height. The height of the first step will have to be figured separately to equal one riser height, adjusted for any difference in floor covering. The top step might also have to be adjusted for a difference in floor height.

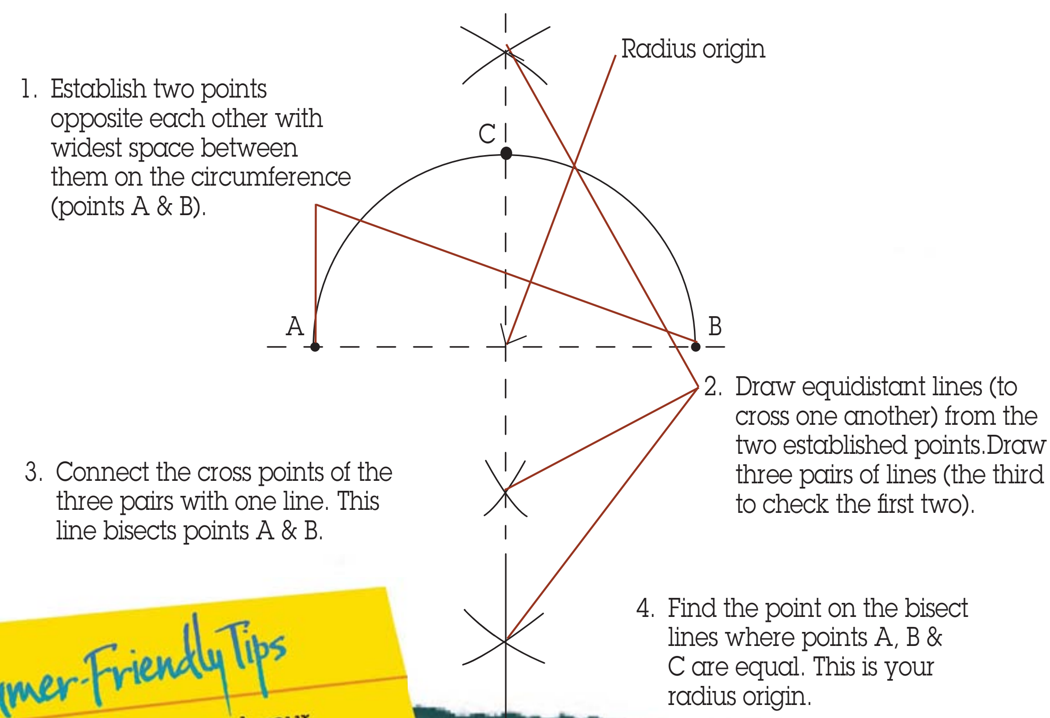
7) Install the Tread Walls

Nail the tread walls in place using the footprint lines. The bottom of the studs will be toenailed into the bottom plate already in place. (See "Tread Walls Nailed in Place" illustration.)

8) Cut and Nail Treads

The treads should all be the same. They will be nailed onto the top of the tread walls and the ledgers. An equal nosing should be maintained the full length of the tread. Make sure the walls stay plumb both ways. Glue each tread to prevent squeaks. (See "Treads Halfway Up Stairs" illustration.)

Bisecting a Line to Establish the Radius Origin

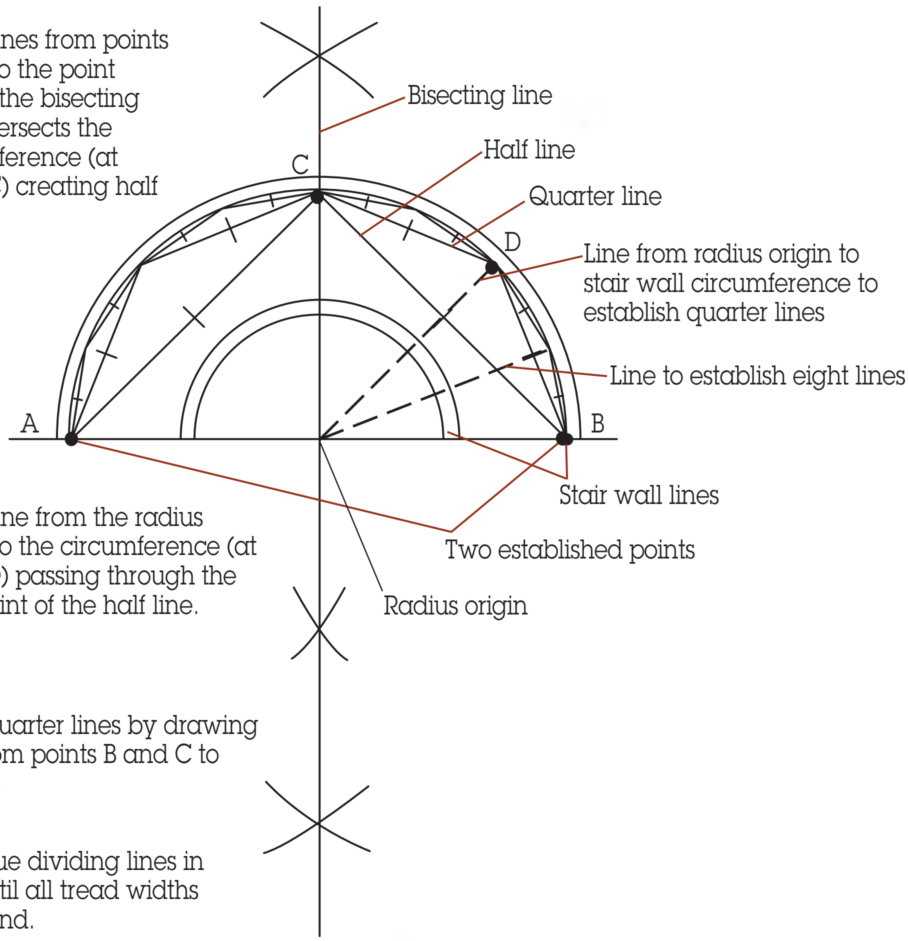


Framer-Friendly Tips

If you daydreamed your way through high school geometry class, you'll need to spend some time learning this process.

Divide Circumference for Treads

1. Draw lines from points A & B to the point where the bisecting line intersects the circumference (at point C) creating half lines.

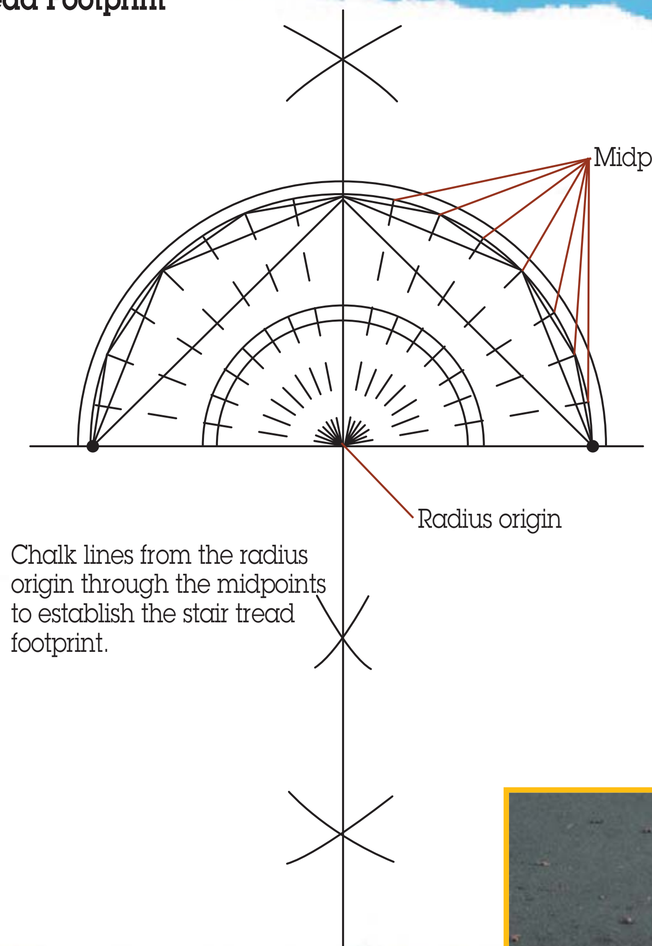


2. Draw line from the radius origin to the circumference (at point D) passing through the mid point of the half line.

3. Draw quarter lines by drawing lines from points B and C to point D.

4. Continue dividing lines in half until all tread widths are found.

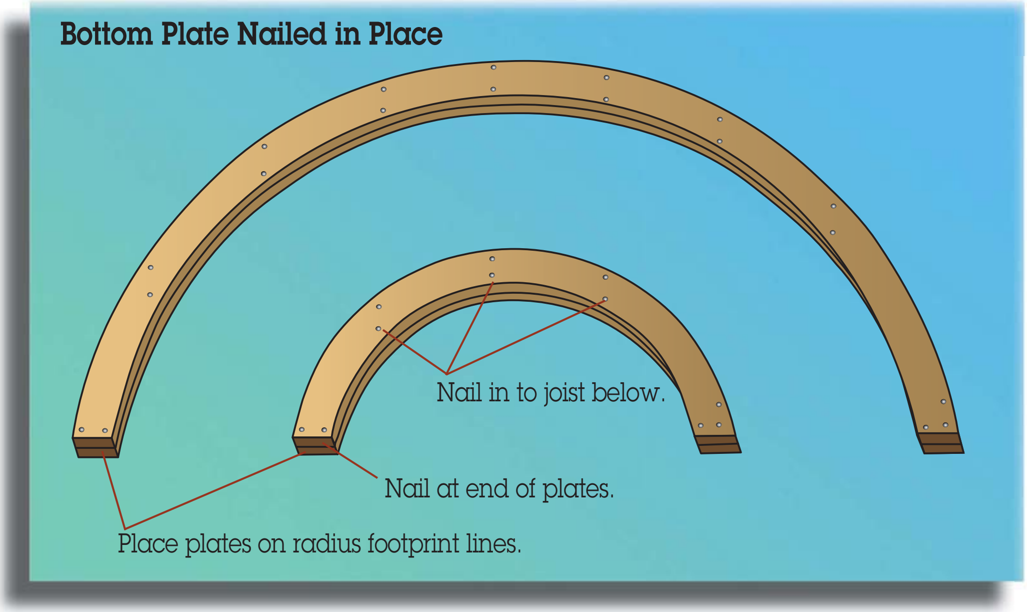
Tread Footprint

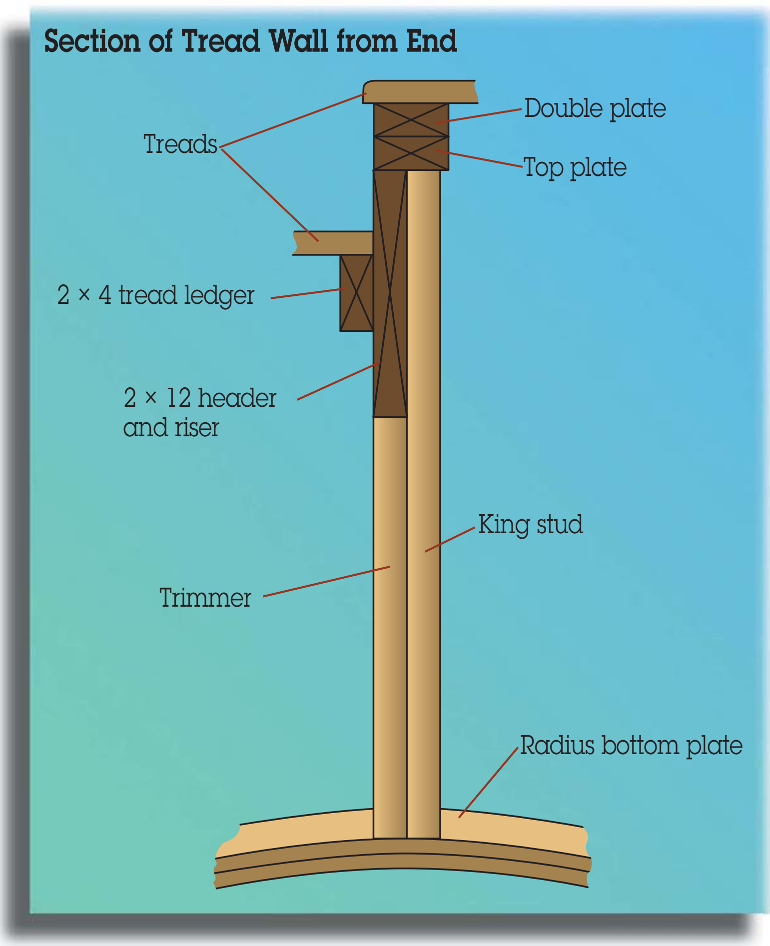


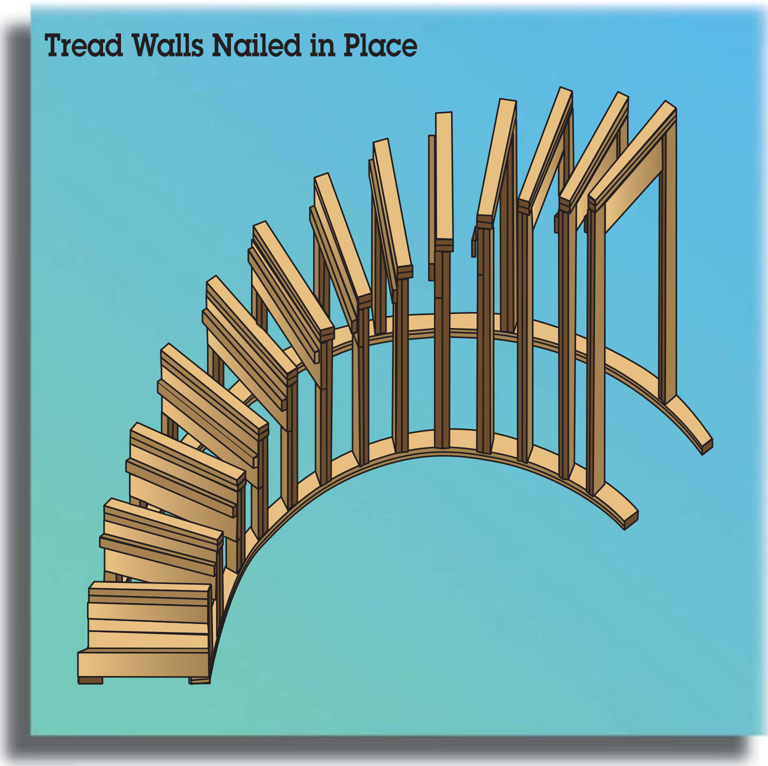
Framer-Friendly Tips

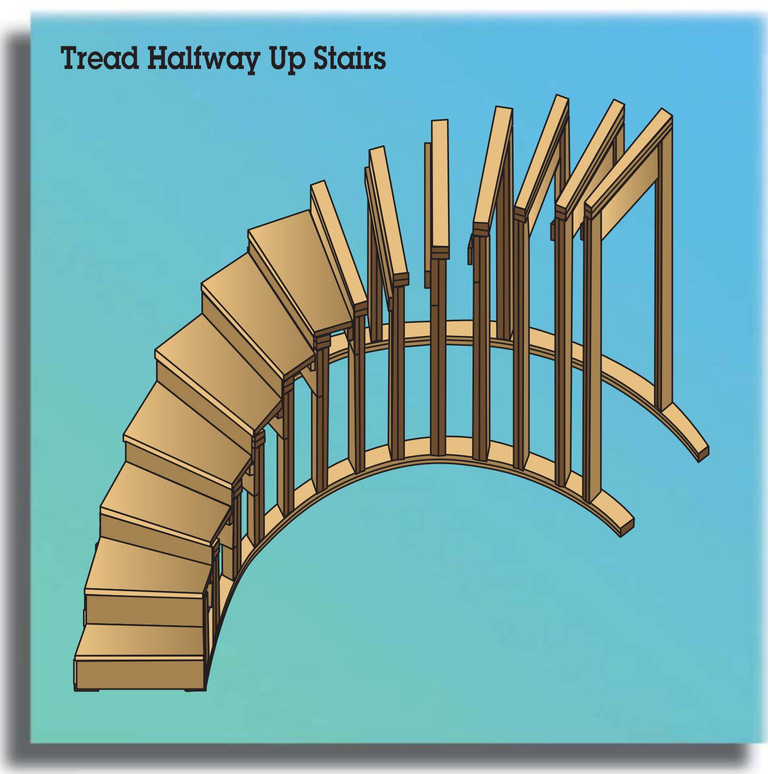
On smaller circumferences, you'll occasionally want to back up your saw as you cut to follow the line.

Cutting curved bottom plate

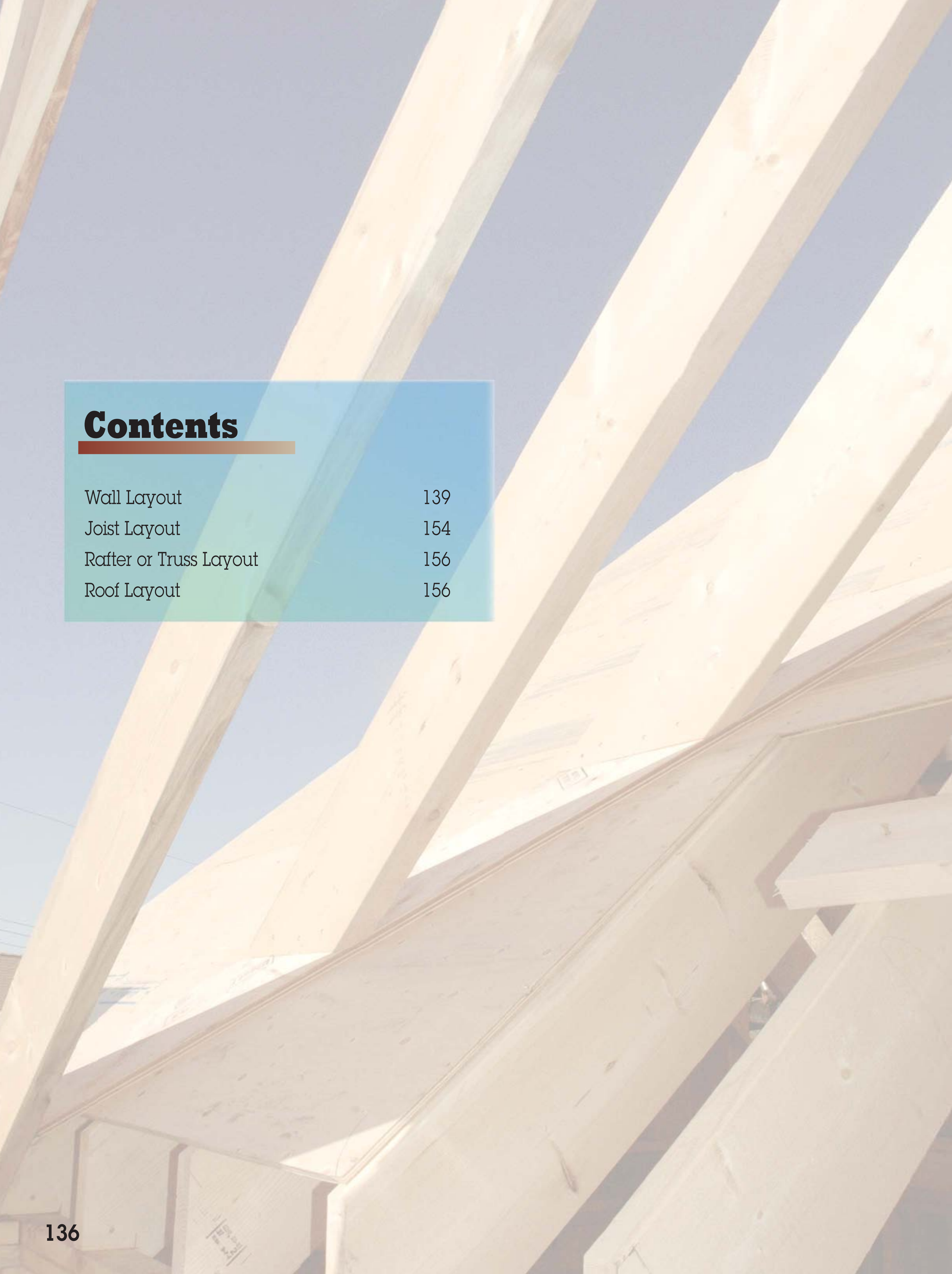

Bottom Plate Nailed in Place
Nail in to joist below.
Nail at end of plates.
Place plates on radius footprint lines.


Section of Tread Wall from End
Treads
Double plate
Top plate
2 × 4 tread ledger
2 × 12 header
and riser
King stud
Trimmer
Radius bottom plate


Tread Walls Nailed in Place


Tread Halfway Up Stairs

Chapter Seven
LAYOUT



Contents

Wall Layout 139
Joist Layout 154
Rafter or Truss Layout 156
Roof Layout 156

Chapter Seven

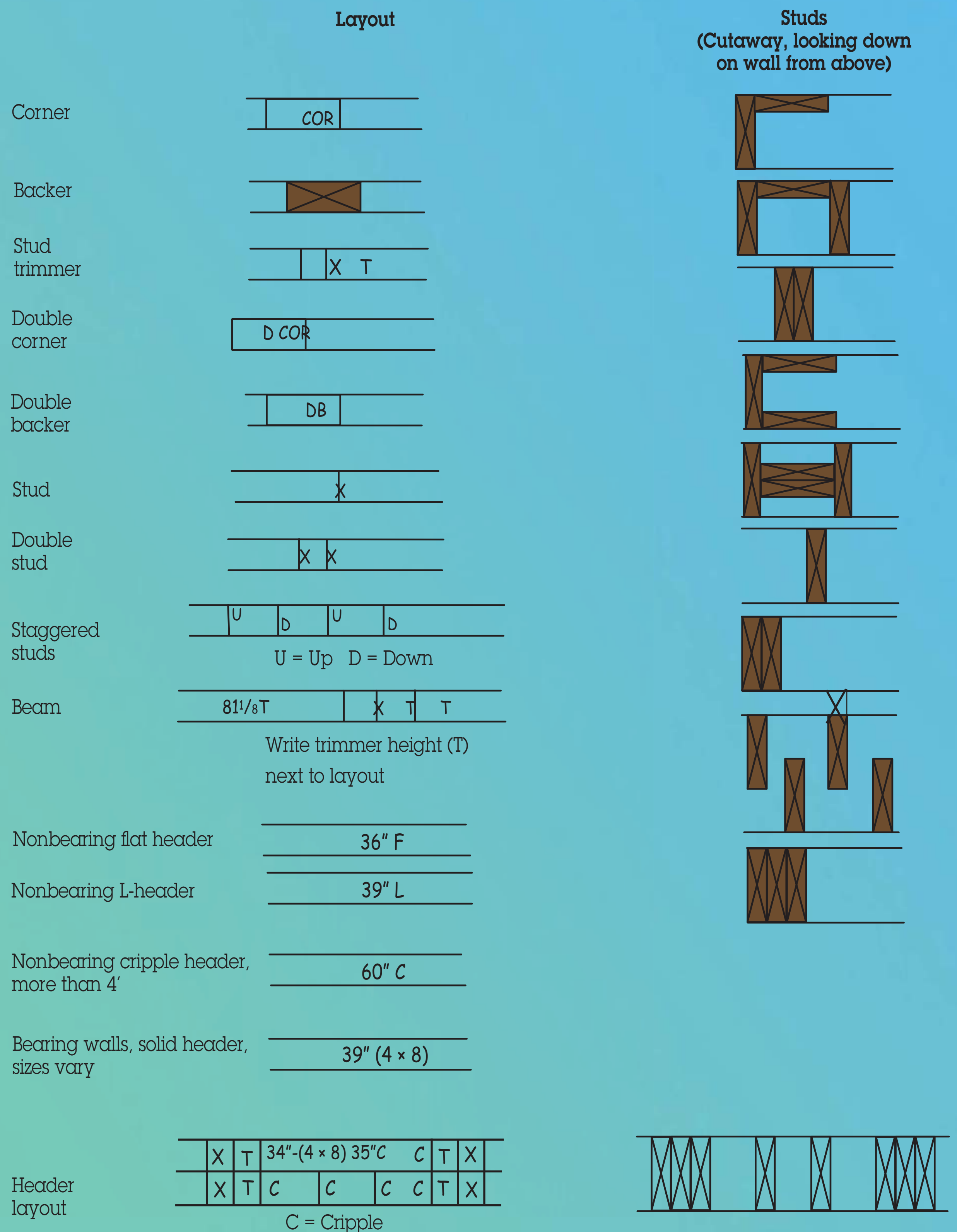
LAYOUT

Layout is the written language of the framer. If the lead framer on the job "writes" clearly, then the framers reading the layout will be able to understand and properly perform the work. It's important to include enough information in the layout so that there aren't any questions. Layout language has been developed by framers over the years, and there are some variations. The version described in this book is quite typical. Feel free to make any changes that reflect practices in your area. If you need to explain something about the layout that isn't shown in this chapter, either write it out on the plates in plain language, or explain it to the person who will do the framing.

Layout for framing requires bringing together the desires of the owner, the written instructions of the architect and engineer, instructions from the builder and/or superintendent, and materials from the supplier—then writing these instructions on job-site lumber in a legible manner so that the framers can build the walls, floors, and roofs without continuous interpretation. This chapter describes this process and explains the written words and symbols the lead framer uses.

The approach you use will depend on the size of the job, the area of the country you are working in and, most of all, the style of the person who taught you framing layout. This chapter presents a common style of layout, with some variations. Any style you use is good, as long as the framers can read and understand it, and you have provided all the information they need to frame the building completely.

Language



Layout
Studs
(Cutaway, looking down on wall from above)
Corner
COR
Backer
Stud trimmer
X T
Double corner
D COR
Double backer
DB
Stud
X
Double stud
X X
Staggered studs
U D U D
U = Up D = Down
Beam
81 1/8T
X T T
Write trimmer height (T) next to layout
Nonbearing flat header
36" F
Nonbearing L-header
39" L
Nonbearing cripple header, more than 4'
60" C
Bearing walls, solid header, sizes vary
39" (4 × 8)
Header layout
X T 34"-(4 × 8) 35"C C T X
X T C C C C T X
C = Cripple

Wall plates positioned vertically for layout

Wall Layout

On many jobs, the basic skeleton of the walls is built, and then the blocking, hold-downs, and miscellaneous framing are filled in as a later operation. There are some disadvantages to installing miscellaneous framing after the basic framing. For example, you may have to notch around wires and pipes. You may even have to come back and set up a separate operation after you have already left the job site. This chapter describes a system that includes everything possible in the layout, so the walls can be framed, complete, all at one time. To do this takes organization and pre-planning, which includes gathering all the information you need before you do the layout.

The positioning of the top plate and bottom plate for layout detailing is a variable that depends on personal preference and the type of operations. The plate can be positioned vertically so that the 1½" width is on top, which makes it easy for marking on the plate. The plate can also be laid flat (horizontally) on top of the chalk lines so that the plates are in the same position as when the walls are standing. This system makes it easy to keep the walls in the proper position, particularly when you have angled walls. A third option (for some exterior walls only) is to position the bottom plate where it will be once the wall is standing, then tack the top plate to it, hanging over the side. This system works well if you want to attach the bottom plate to the floor and then stick-frame the wall.

The layout language varies, but all layout styles are similar. The chart on page 138 shows the basic layout language. Page 144 shows additional language. Although the parts of the walls are typically the same in different areas of the country, quite often they are referred to by different names. For example, a *backer* is also known as a *channel* or *partition*. Even the term "layout" can have different meanings. Sometimes layout is understood to be the total process of chalking the lines for the wall locations (snapping), cutting the plates, and writing the layout language on the plates (detailing). It is not important what terms are used, as long as there is clear communication.

Wall layout is the process of taking the information given on the plans and writing enough instructions, in layout language, on the top and bottom plates so the framer can build the wall without asking any questions.

Following is some general information that must be considered before starting. Unless otherwise noted, all layout discussions will assume 2 × 4 studs at 16" O.C. (on center).

Where possible, we want joists, studs, and rafters to rest directly over each other.

Before layout is started, establish reference points in the building for measuring both directions of layout and use those points for joist, stud, and rafter/truss layout throughout the building.

Check the building plans for a special joist plan or rafter/truss plans indicating layout.

Select a reference point which allows you to lay out in as long and straight a line as possible, and which ensures that a maximum number of rafters/trusses are directly supported by studs.

Wall Layout Steps

1. Spread the top plate and bottom plate together in chalk lines. If a plate is not long enough, cut the top plate to break on the middle of the stud and four feet away from walls running into it.
2. Place plates in position with chalk lines.
3. Lay out for backers from chalk lines.
4. Lay out stud trimmers and cripples for windows and doors.
5. Lay out studs.

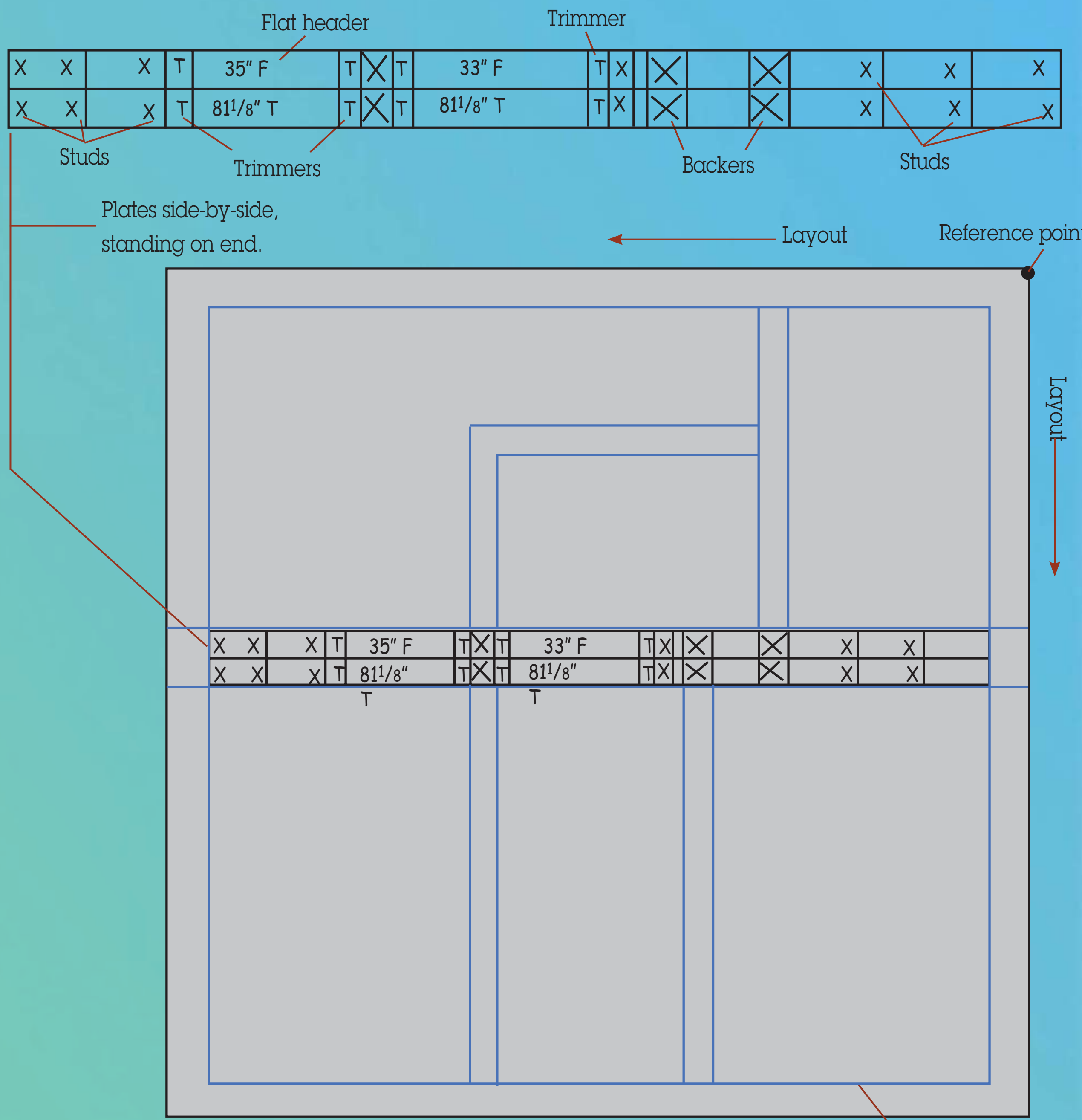
Chalking Lines

"Chalking lines" is the process of marking on the subfloor where the walls are to be placed. Red chalk makes a permanent line and is easily seen. Blue chalk can be erased and is good to use if the lines might have to be changed. Using different colors allows you to distinguish between old and new lines.

Before chalking, when possible, check foundation and floor for square. Walls must be square, plumb, and level. If necessary, adjust your chalk lines accordingly.

Measurements for chalk lines are derived from wall dimensions as given in the plans. If the plans show finished walls, be sure to subtract the appropriate amount to get your framing measurements.

Layout with Chalk Lines



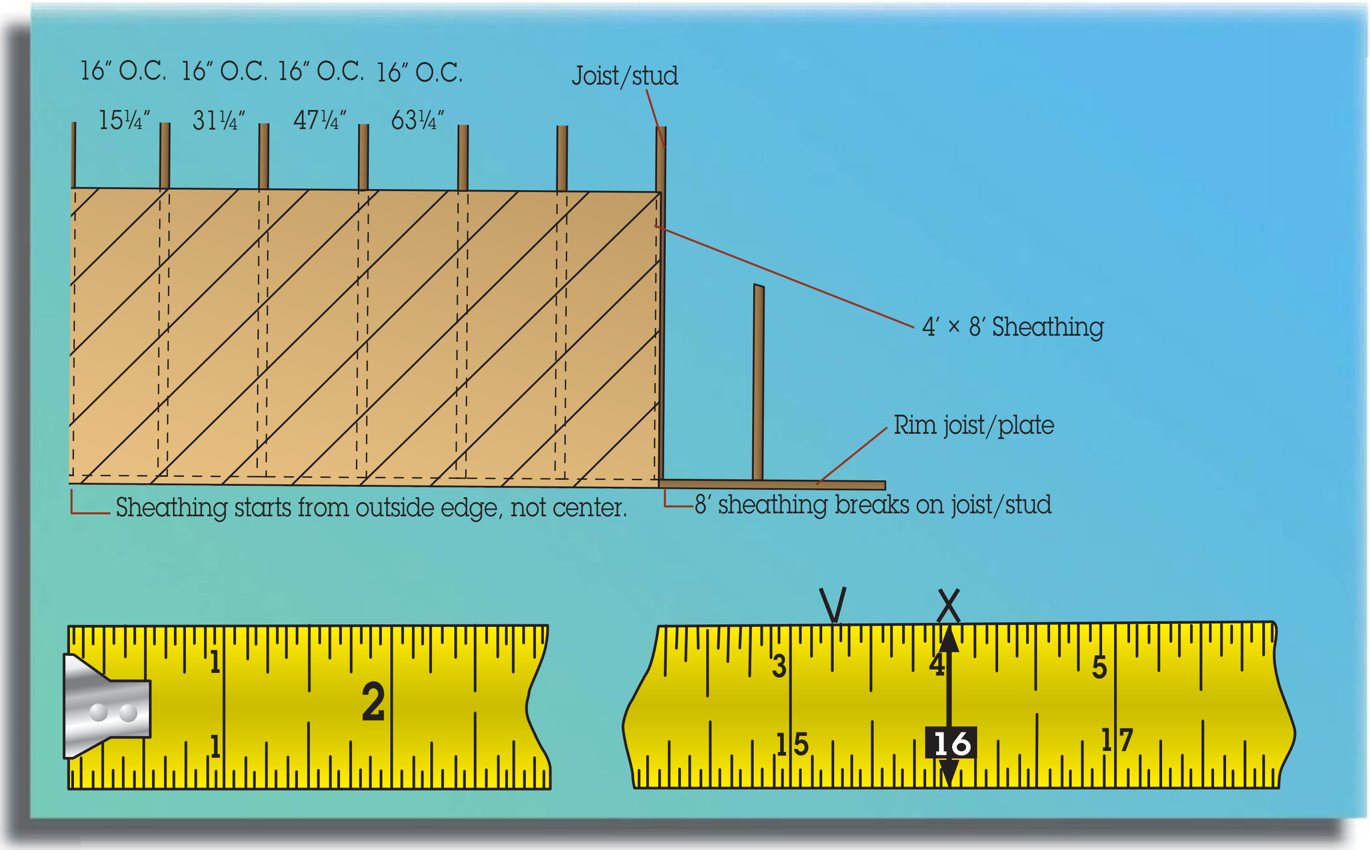
Chalk lines on subfloor sheathing using dimensions on plans.

Pulling Layout from a Corner (16" O.C.)

Pull layout so that sheathing will break in the middle of a joist/stud. Hook tape on the outside edge of rim joist/plate. Pull and locate 16" on tape, then measure back half the thickness of joist/stud (¾" for 2× stock) and mark. This puts the layout mark on 15¼". Make an X on the correct side of the layout mark to show the location of the joist/stud.

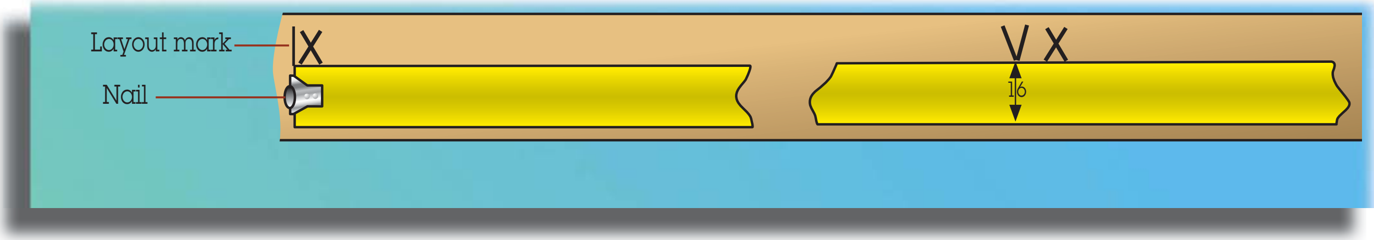
Continue marking in this way for each subsequent 16" space, thus: 31¼", 47¼", 63¼", etc. Finish by drawing square lines through the mark.

The reason for subtracting the ¾" is that the 4' × 8' sheathing will be installed from the *outside edge* of the rim joist/plate, not from the center.



Pulling from an Existing Layout (16" O.C.)

Set end of tape on a layout mark; pull and mark 16", 32", 48", etc. Make an X on the correct side of the layout mark and square a line through the mark. For a long span, set a nail on the existing layout mark, hook tape on the nail, and pull layout.



Miscellaneous Wall Framing Layout

Each building has unique characteristics that require special attention. Hold-downs, shear walls, blocking, backing, special stud heights, and posts are some of the more common miscellaneous framing items. The framing language for these framing items is not well-defined because the operations frequently change and the same ones are not always used. The Miscellaneous Layout Language Chart on the next page gives you an idea of how these framing tasks can be communicated.

Hold-Downs

Hold-downs are probably the most difficult to mark correctly. They vary from location to location and require different studs or posts for connecting.

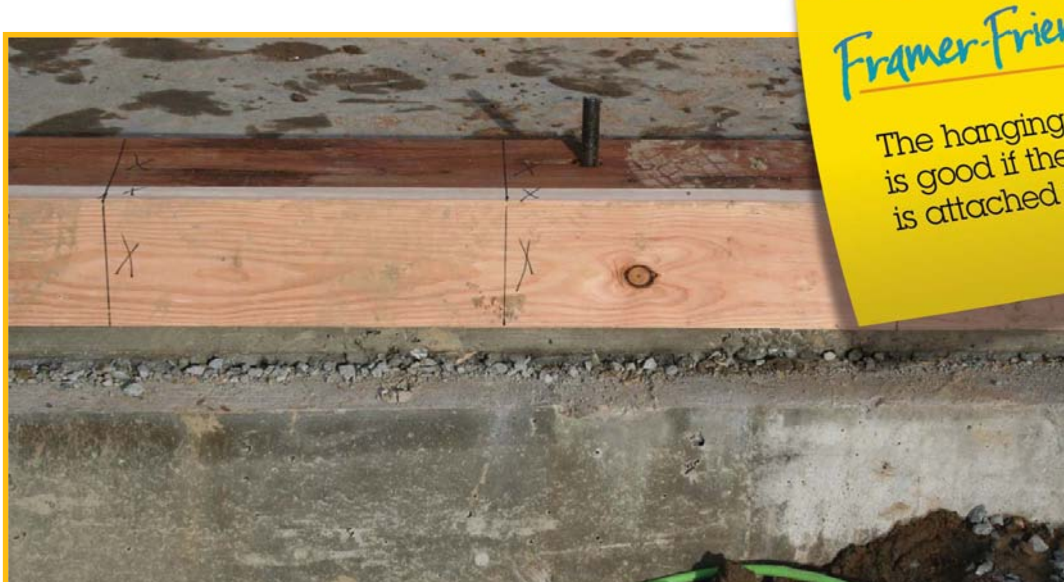
Framer-Friendly Tips

The horizontal method is good for angles and helps you visualize where the wall locations are.

Wall plates positioned horizontally for layout

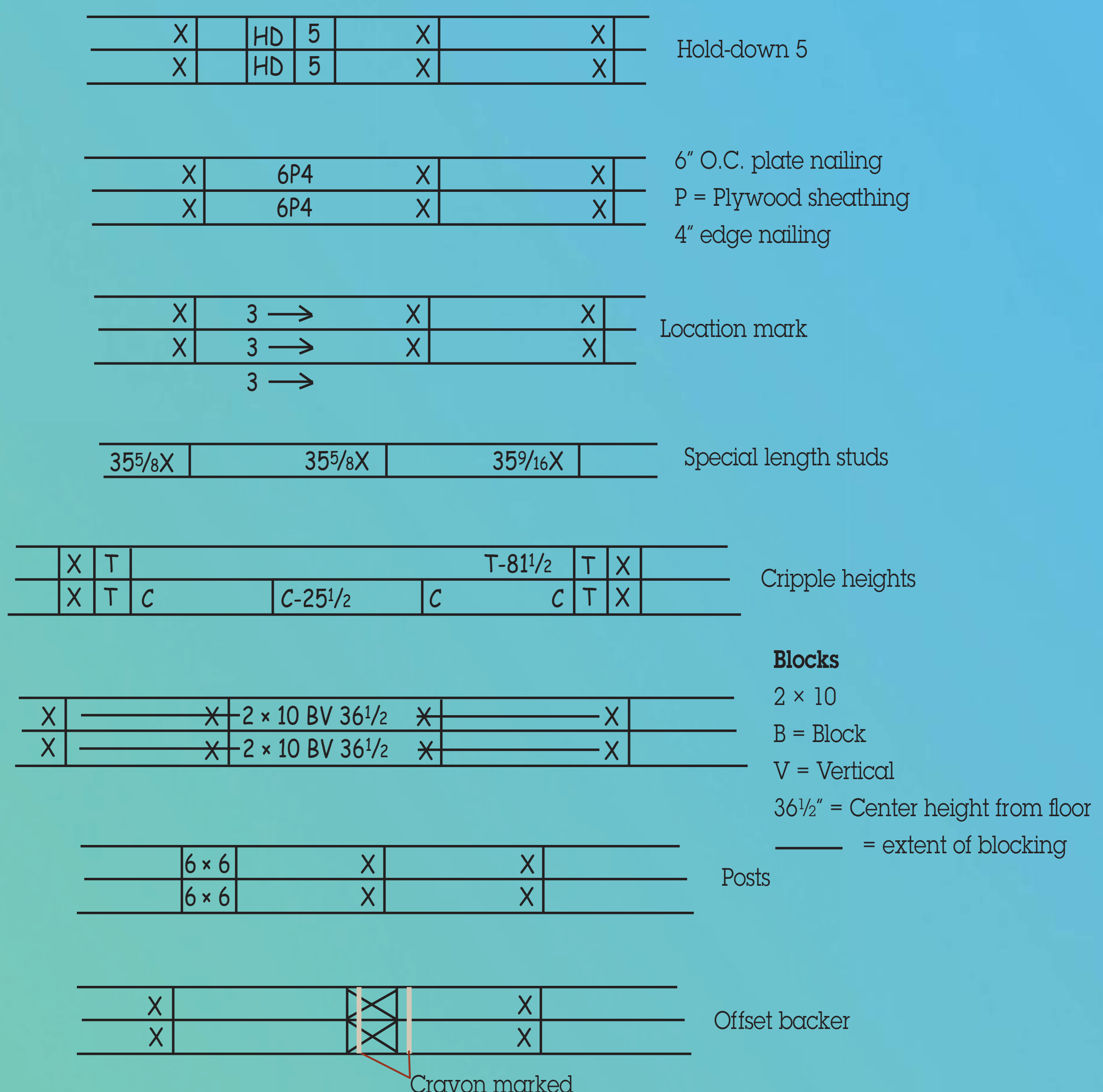
Framer-Friendly Tips

The hanging plate method is good if the bottom plate is attached to the floor.



Top plate tacked to bottom plate hanging over edge of concrete for layout

Miscellaneous Layout Language Chart



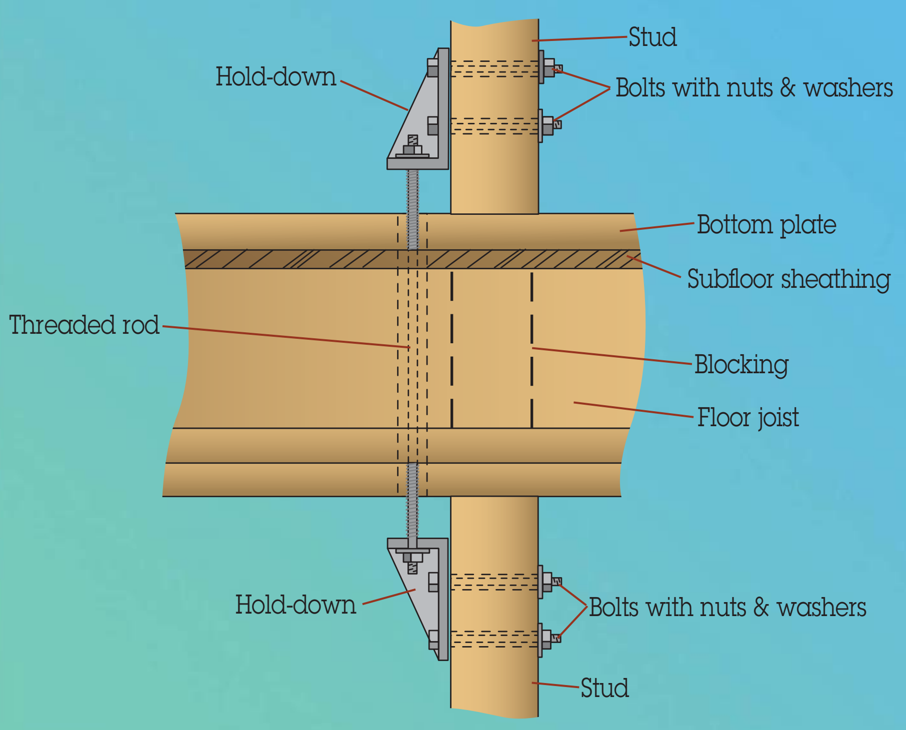
There are also different types of hold-downs, and each manufacturer has its own identification system. There are, however, four basic styles of hold-downs that you need to show in your wall layout.

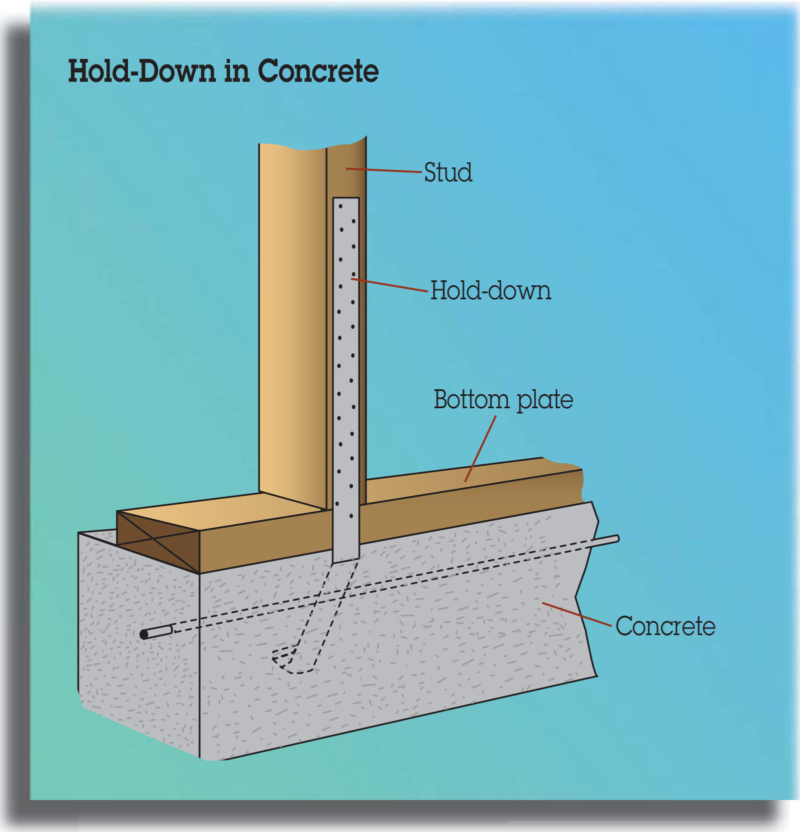
1. Basic hold-down: bolts, nails, or screws to the hold-down post or studs. This type is typically attached to an anchor bolt in the foundation or bolted to an all-thread rod that is connected to a hold-down in the wall below. (See "Hold-Downs with Floor Between" illustration.)
2. Hold-down already embedded in the concrete, which needs only to be attached to the wall. (See "Hold-Down in Concrete" illustration.)
3. Strap used to connect the top of one wall to the bottom of the wall above. (See "Strap Wall to Wall" illustration.)
4. Hold-down that is continuous between all floors from the foundation to the top floor. (See "Hold-Down, Continuous" illustration.)

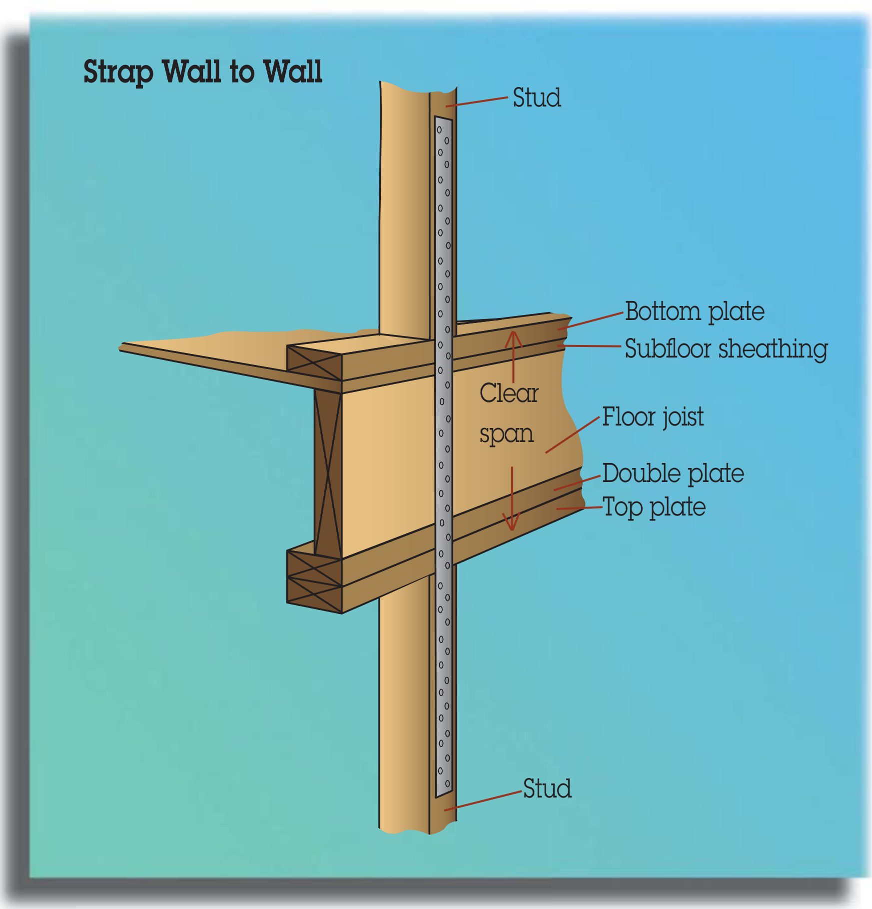
The difficulty in laying out for hold-downs is knowing what to write on the plates so that the requirement will be easily understood. The best thing to do is to explain to all framers at the beginning of each job what symbols you are using to indicate hold-downs. Use the same language when possible at different jobs. The most common symbol for hold-downs is HD, followed by the number representing the size of the hold-down—for example, HD2 or HD5.

When you are laying out for hold-downs, it's important to get the layout in the right location. Since the purpose of a hold-down is to connect the building to the foundation, the hold-downs must

Hold-Downs with Floor Between



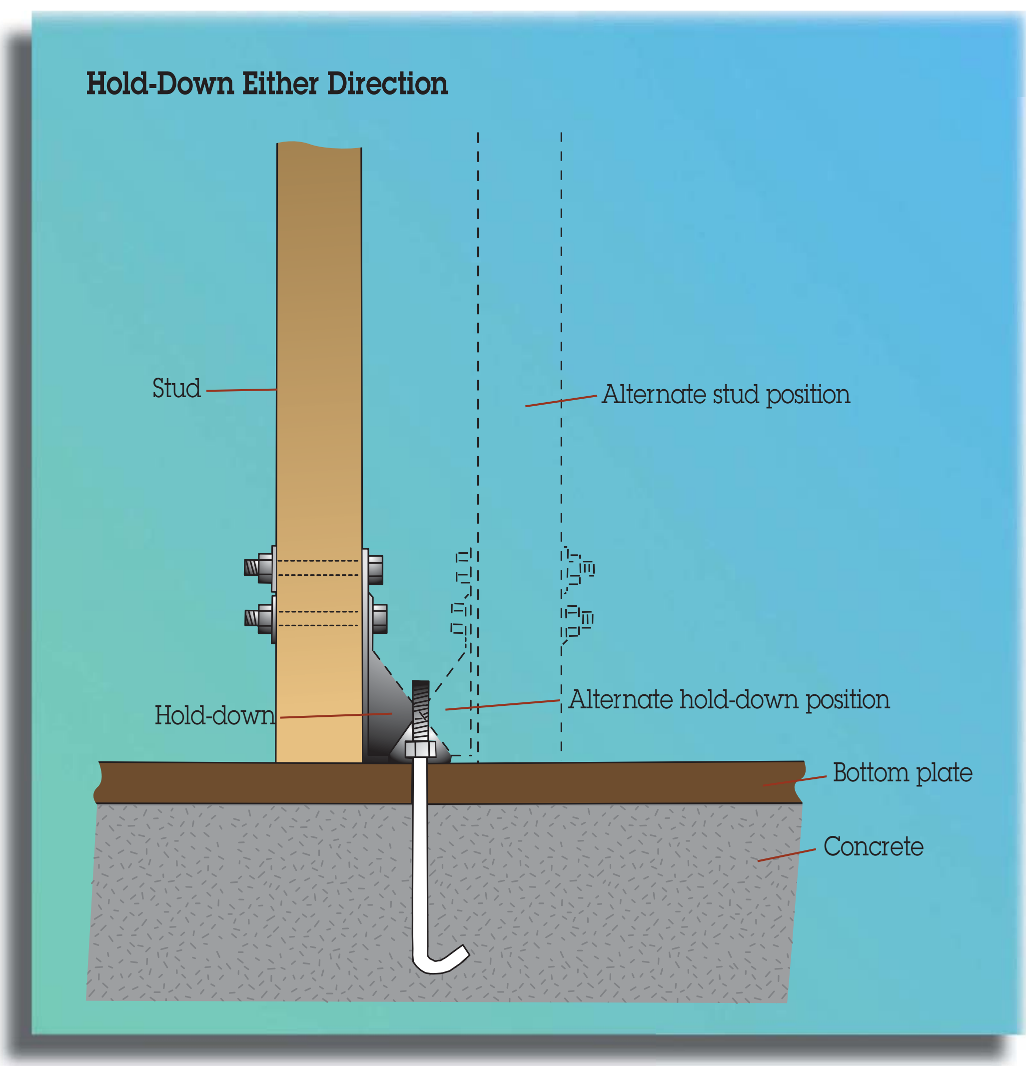

Hold-Down in Concrete
Stud
Hold-down
Bottom plate
Concrete


Strap Wall to Wall
Stud
Bottom plate
Subfloor sheathing
Clear span
Floor joist
Double plate
Top plate
Stud

line up with the anchor bolt in the foundation below them. Hold-downs are typically found at the end of shear walls. Engineers sometimes position hold-downs attached to posts at the ends of walls or within a specific distance from the ends of walls. If that information is not specified, keep the hold-down as close to the end of the wall as possible. If the hold-down anchor bolt is already in the concrete, then you can only position it in two locations—one on either side of the hold-down anchor bolt. (See "Hold-Down Either Direction" illustration.)

If the epoxy system is specified for installing the anchor bolts later, you have more options. A good rule of thumb is to keep the hold-down within one foot of the end of the wall. However, the shorter the wall, the closer the hold-down should be to the ends of the wall.

When laying out for a hold-down, you want the studs or post to be in the correct position in relation to the anchor bolt or hold-down in the wall. A good way to make sure the distance from the studs to the anchor bolt is correct is to use one of your hold-downs to mark the pattern and location of the studs or post. (See "Hold-Down as Pattern" photo.) If you do not have a hold-down available for this purpose, you can use the manufacturer's hardware catalog to find the distance from the anchor bolt to the studs.



When you are laying out for the hold-downs on an upper floor, it is helpful to mark the location of the hole to be drilled in the plate and the floor. You have to locate the hole anyway to lay out the studs. By marking its location, you are saving someone else from having to locate it again. It is easiest to go ahead and drill the holes through the floor then, before the walls are built. These holes can be oversized to make alignment easier.

Shear Walls

Shear walls have unique characteristics, but the most common information a framer needs to know about them is the type of sheathing, the edge nail spacing, and the nail spacing for nailing of the bottom plate. This information can usually be found in a shear wall schedule in the plans. The sheathing used is typically either plywood or OSB, commonly identified as "W," or gypsum, identified as "G." The edge nailing is designated as a number after the W or G, and the floor nailing as a number before the W or G. An example could be "6W4," meaning that the bottom plate is nailed at 6" on center, the sheathing is plywood, and the edge nailing is 4" on center. The language for shear walls can be written on the plates with the other language, but it is best to also write it on the top of the bottom plate. That way, when you get around to nailing the wall down, the nailing pattern will still be visible.

Hold-down as pattern

Different Length Studs

Some walls will have studs of different lengths. Examples are rake walls or walls where the concrete is not level, and the studs are cut to compensate. In such cases, you will want to write the stud lengths on the plate next to the studs.

Cripples

The cripples to be framed over and under the windows and doors will be laid out on the same layout as the studs. You will mark them with a line and a "C," and indicate their lengths on the plates—for example, C-25 1/2". Mark the cripple height for the cripples that go below the window on the bottom plate, and the cripple height for the cripples that go above the window or door on the top plate.

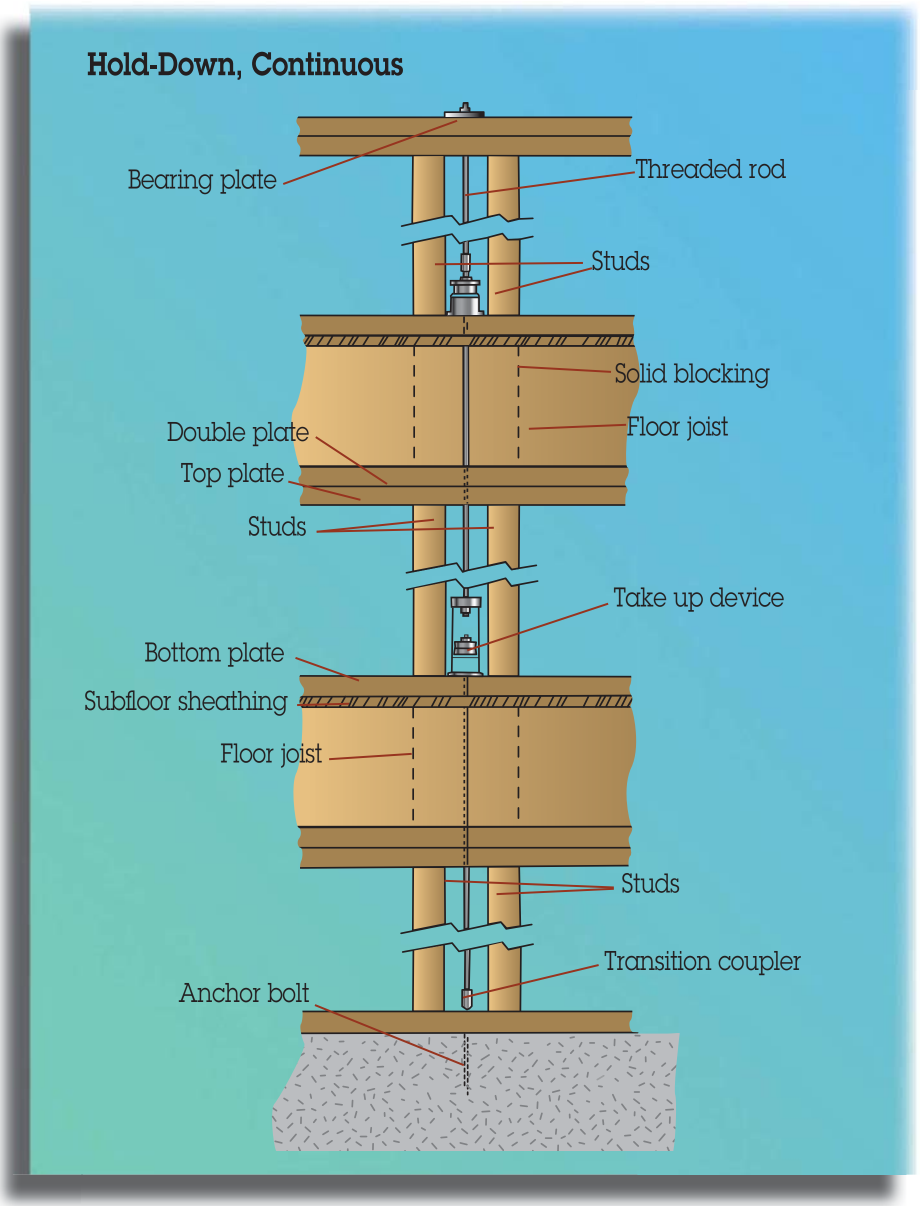
Blocking

Many kinds of blocks are installed in walls. Some common blocks are fire blocks, medicine cabinet blocks, cabinet blocks, stair rail blocking, curtain rod blocking, and wainscot blocking. The hardest part of laying out for these blocks is getting the right information so you can figure out their location. You might as well find this information before you build the wall, since it is easier and more efficient to install the blocks as you build the walls than afterwards.

Two basic types of blocks are installed in walls. One is a horizontal block that fills the whole stud space as a fire block does. The other is a vertical block that is flush with one side of the wall. (See "Vertical and Horizontal Blocks" illustration.)

The vertical block is more often used for backing to provide a greater area for attaching fixtures. To position a block in the wall, you need to know if the block is vertical or horizontal, the height of the block, and the size. This information is written with a "B" first, indicating blocking, and then either a "V" or an "H," indicating a vertical or horizontal position. The height is then written following the V or H, indicating the center height of the block from the subfloor sheathing or the concrete. If the block is vertical you will need to write "U" or "D" indicating up or down, showing which side of the wall the block will be on. If the block is the same width as the studs in the wall, then that is all the information that is necessary. However, if the block is a different width than the wall, then the size of the block should be written before the "B."

If there are a number of blocks in a row, as is the case with fire blocking, you can just mark one stud space and (with a carpenter crayon) draw a line in both directions to indicate the extent of the blocking.



Backer Layout

Normal backer layout has the layout marks for a backer aligned with the position of the wall that will be nailed into the backer. This isn't always the case, however. Sometimes it is better to move the backer so it does not line up. For example, you might have a door next to the backer, with only 2½" between the backer and the rough opening of the door. Instead of having a 1½" trimmer and a 1" king stud, you just attach a 1½" trimmer to the backer and move it over ½".

The best way to mark this on the wall layout is to mark both positions of the backer. The first position is where the backer would align with the wall, and the second is where the backer was moved and where it will be nailed. A good way to distinguish the two positions is to mark over the one line with a carpenter's crayon (keel or lumber crayon). This layout information will help when the walls are nailed together. It will also help when you are cutting the double plate of the joining wall to overlap. (See "Backer Move" illustration.)

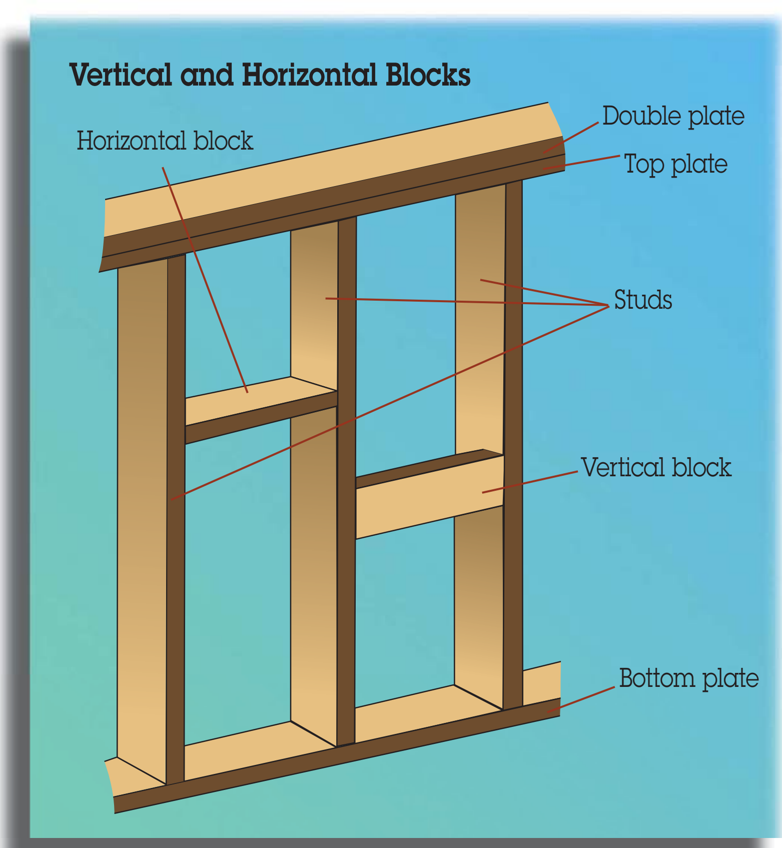
Special Stud Layouts

It is important to be aware of special stud layouts, such as might be required for shower or bathtub center valves. Showers and tubs are typically 30" wide. Space must be allowed in the middle for the valves. It's usually easy to find the center and then set a stud 8" on center each way. (See "Plumbing Studs" illustration.)

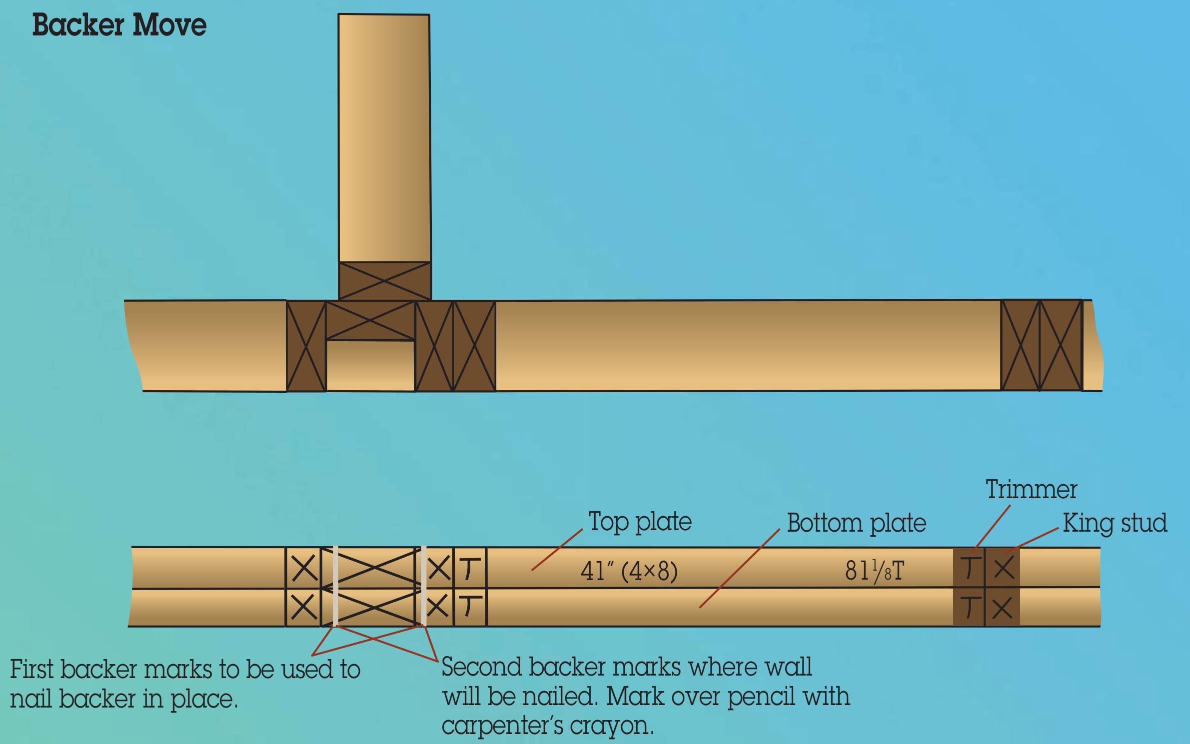
Recessed medicine cabinets are another special layout. If they require a 14 1/2" rough opening, they could fit between standard 16" O.C. spaces. More often than not, however, the design requires installation in a particular location that requires special layout.

Backing for Siding

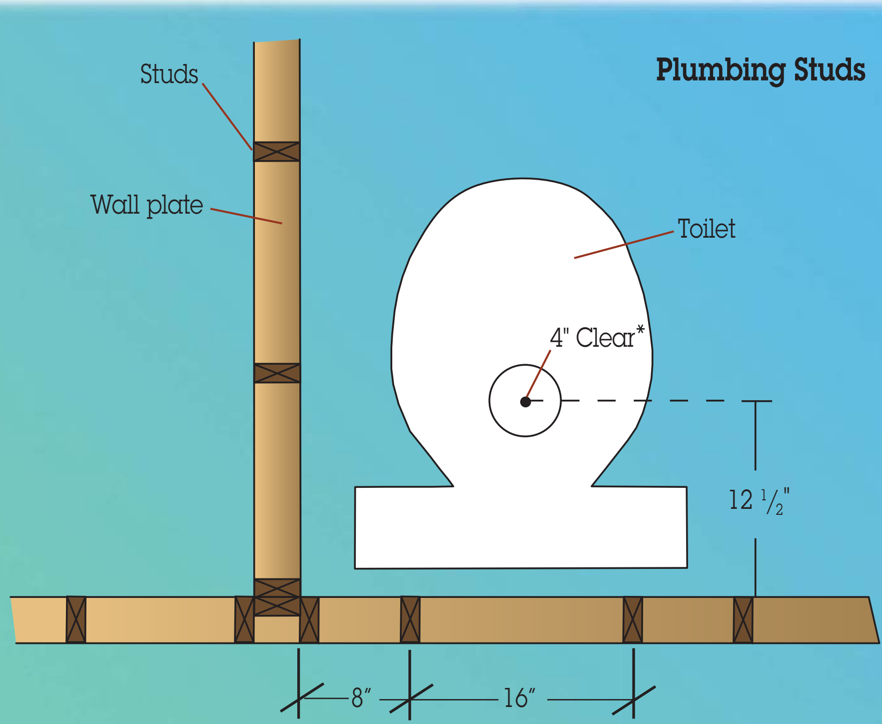
Different types of siding require different types of backing. For example, bevel siding with a wide window will require an extra stud or extra backing along the window to attach the siding.



Backer Move



Plumbing Studs



Toilet clearance

*These are common dimensions, but should be checked with the builder. They will come in handy for laying out floor joists so you don't lay out a joist in the middle of where a toilet pipe must go.

Structural Support

Often a beam or girder truss, or some other structural member, requires structural support all the way to the foundation, but that support is not shown on the plans. Check and lay out for upper floor structure support when laying out walls.

Location Marks

Another mark you might need to make on your walls is for location. If you have to move the plates to make room to build walls, then you need to mark the location for all the walls to make sure you know where they go when you are ready to build them. It is best to use a crayon and mark a number and an arrow on each plate. The top and bottom plates will be marked with the same number. The arrows will point in the same direction as all the other walls that run in that direction. In addition to marking the plates, mark the number and the arrow on the floor next to the plates. (See "Plate location marks" photo.)

If you are laying out walls on a concrete slab, then you will have to contend with plumbing and electrical pipes. Before you start your layout, notch the bottom plate to fit.

Layout Methods

Use the Correct Order

When you perform the layout, follow a prioritized order. For example, trimmer and king studs for doors and windows take priority over studs. That is because if a stud falls on the location of a trimmer or king stud, then the stud is eliminated. Using a certain order for layout also helps you keep track of where you were if you are pulled off layout and have to come back later to pick up where you left off. The order should be doors and windows first, then bearing posts, backers and corners, then hold-downs—followed by special studs like medicine cabinet studs, then regular studs, and finally miscellaneous framing, such as blocks.

Align Framing Members

It is good practice when laying out studs to align the roof trusses, floor joists, and studs. This is not entirely possible in most cases because the studs are typically 16" O.C., while the roof trusses or rafters are 24" O.C. However, you will at least line up every third truss or rafter. If the studs are 24" O.C., then they need to align with the trusses or rafters. Aligning the studs, joists, and trusses or rafters not

Plate location marks

only makes good sense structurally, but makes it easier for the plumbers and electricians to run their pipes and wire between floors.

Consult the Roof and Floor Drawings

To start laying out your studs, you need to know the layout of your roof and floor systems. If you are using dimensional lumber, then you can most likely start the layout for your roof and floor wherever it is convenient. If, however, you are using I-joists or roof trusses, the layout will probably be defined on a set of shop drawings provided by the supplier. You should receive a set of these shop drawings before you start laying out your studs, so that you can align wherever possible. Once you have decided on a starting point for your layout in each direction, use the same layout throughout the building. Although it is not structurally necessary to align nonbearing interior walls with multiple floors, it is helpful to have the studs aligned for the plumbers and electricians.

A Word of Caution

Some production framing techniques speed up the layout process, but be careful, if you use them, not to sacrifice quality. For example, instead of using the X with a line next to it to indicate a stud, a single line can be used to represent the center of the stud. Be careful with this designation, because the studs need to line up with the middle of the wall sheathing. If you figure that you allow $1/8$" for expansion between the sheets of sheathing, that only allows $11/16$" for nailing each side. You cannot afford to be off by even a small amount and still get enough stud to nail to. If you use this system, you also have to be sure that your framers are competent and can align the studs properly.

Other Tasks that Can Be Done Along with Layout

Some items can be attended to while you are performing the layout. One is to cut a kerf in the bottom of the bottom plate at door thresholds when they are sitting on concrete. This kerf (about half the thickness of the plate) allows you to cut out your bottom plate after the walls are standing without ruining your saw blades on the concrete. (See "Kerf cut [threshold cut]" photo.)

You can take care of another item while drilling the bottom plate to install over anchor bolts. When the bottom plate is taken off the bolts to do the layout, it can be turned over and accidentally built into the wall upside-down. This problem can be prevented by using a carpenter crayon to mark "UP" on the top

Kerf cut (threshold cut)

of the plate before it is removed from the bolts. Angle walls have the same potential for getting built with the plates backward. You can also mark them as they are being laid out.

Layout Tools

There are some tools that can help with layout, particularly with multi-unit or mass production-type framing. One of these is the channel marker, a template made to assist in laying out corners and backers. Another is a layout stick. The layout stick is 49½" long and is placed on the plates to act as a jig for marking studs. (See "Channel marker and layout stick" photo.)

Joist Layout

Floor Joist

Joist layout is relatively easy compared with wall layout. It uses the same basic language as walls.

Special layout for joists includes the area under the toilet and shower drain. It is easier to move a joist a couple of inches or even to add a joist than to come back and "header-out" a joist because the plumber had to cut it up to install pipes. On larger buildings, there may be shop drawings for the floor joists that can be used for your layout. The shop drawings should show the locations of openings and how they should be framed. (See "Joist Layout Language" illustration.)

Channel marker & layout stick

Joist Layout Principles

Joist layout is the process of taking the information given on the plans and writing enough instructions on the top of the rim joist or double plate so the joist framer can spread and nail the joists without asking any questions.

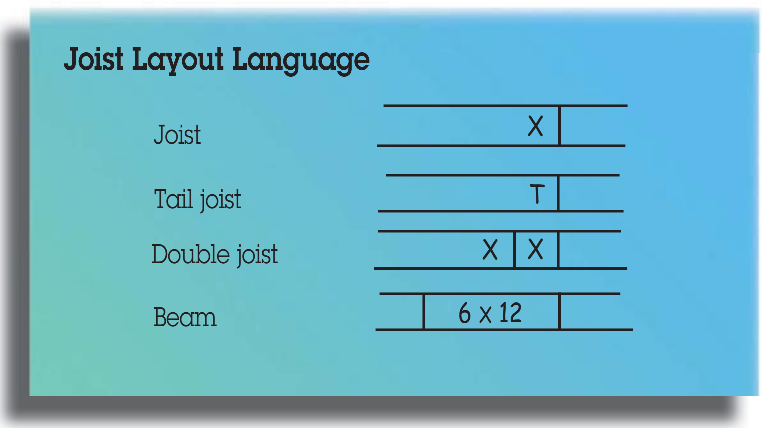
Where possible, we want joists, studs, and rafters to set directly over each other.

Before layout is started, establish reference points in the building for measuring both directions of layout and use those points for joist, stud, and rafter/truss layout throughout the building. Check the building plans for special joist plan or rafter/truss plans indicating layout. Select a reference point which allows you to lay out in as long and straight a line as possible, and which ensures that a maximum number of rafters/trusses are directly supported by studs.

Check plans for openings in the floor required for stairs, chimneys, etc.

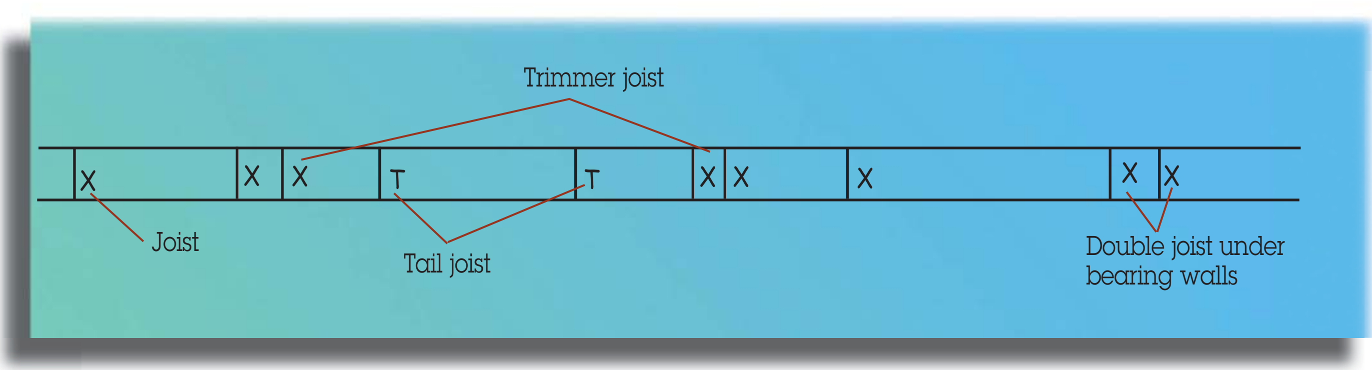
Check plans for bearing partitions on the floor. Double joists under bearing partitions running parallel.

Check locations of toilets to see if joists must be headed-out for toilet drain pipes.



Joist Layout Steps

1. Layout for double joist, trimmer joist, and tail joist.
2. Layout for other joists.



Rafter or Truss Layout

Rafter or truss layout, like floor joist layout, is relatively easy compared with wall layout. Sometimes it is helpful to lay out for rafters or trusses on the top of the double plate so that once the wall is standing, the layout will already be done, and you won't have to do it from a ladder. (See "Rafter layout on walls before the wall is stood up" photo.)

Special layout is often required for ceiling can-lights. Check on necessary clearance to make sure you provide enough room.

Roof Layout

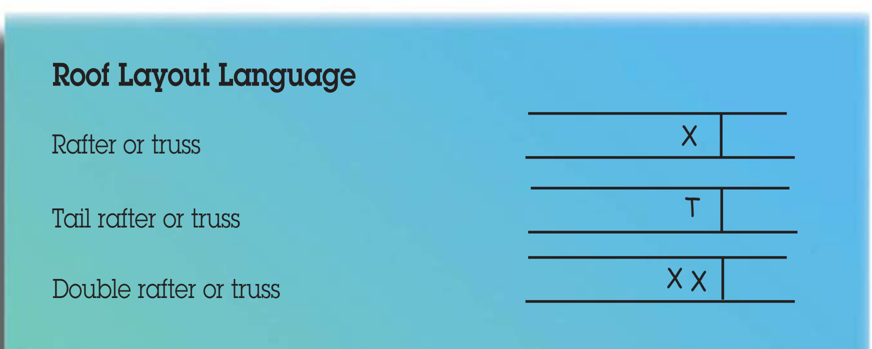
Roof layout is the process of taking the information given on the plans and writing enough instructions on the double plate for the roof framer to spread and nail the rafters or trusses.

Use the same reference points established for floor and wall building for starting layout on the roof.

Roof rafters and trusses are sometimes 24" O.C. as compared with 16" O.C. for floors and walls. In that case, only every third truss or rafter will be over a stud.

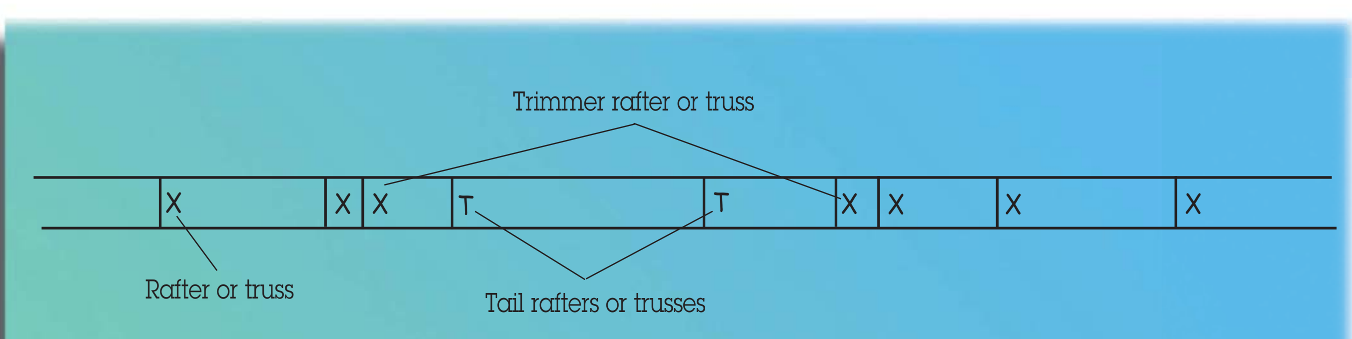
Before layout is started, check plans for openings in the roof required by dormers, skylights, chimneys, etc.

For roof trusses, lay out according to truss plan, especially for hip-truss packages.



Roof Layout Steps

1. Lay out for doubles, trimmers, and tail rafters or trusses.
2. Lay out for other rafters or trusses.



Rafter layout on walls before the wall is stood up

Framer-Friendly Tips

Be creative with your layout language as needed. Just make sure the framer understands it.

Conclusion

Writing layout is just like writing anything else. If the person reading it understands what you want to say, then you've done a good job. When you are done with the layout, take a look at it to make sure you can read it. If your writing is not showing up clearly, you might try a different brand of carpenter pencil. There are different leads, and some write better than others, depending on the condition of the wood. You can also use indelible marking pens, which are especially good on wet lumber.

Review the layout with the framer who will be reading it before he starts. If a framer doesn't understand your layout, it takes more time for him to try to figure it out than for you to explain it to him. A little extra time spent on layout is usually a good investment. It's not easy taking information from all the different sources that combine in the construction of a building and making it legible for framing, but if the layout is communicated clearly, it will help the framers do their work in an organized and productive manner.

Chapter Eight
ENGINEERED WOOD PRODUCTS

Contents

Engineered Panel Products 162
Engineered Lumber Products 163

Chapter Eight

ENGINEERED WOOD PRODUCTS

Engineered wood products have been around for years, particularly in the form of plywood, glu-lam beams, and metal-plate-connected wood trusses. I-joists are more recent, as are LVLs (laminated veneer lumber), PSLs (parallel strand lumber), and LSLs (laminated strand lumber).

It is not the intent of this chapter to explain everything there is to know about engineered wood products, but rather to make you familiar with this category of materials, and give you a sense of what to look out for when you are working with them.

Engineered wood products (EWP) fit into two general categories, **engineered panel products (EPP)** and **engineered lumber products (ELP)**. The first group includes plywood, oriented strand board (OSB), waferboard, and composite and structural particleboard.

The second group includes I-joists, glu-lam beams, metal-plate-connected wood trusses, and structural composite lumber (LVLs, PSLs, and LSLs).

Engineered Panel Products

Engineered panel products are so common that their uses are defined in the building codes. Specific applications vary from job to job, and from manufacturer to manufacturer.

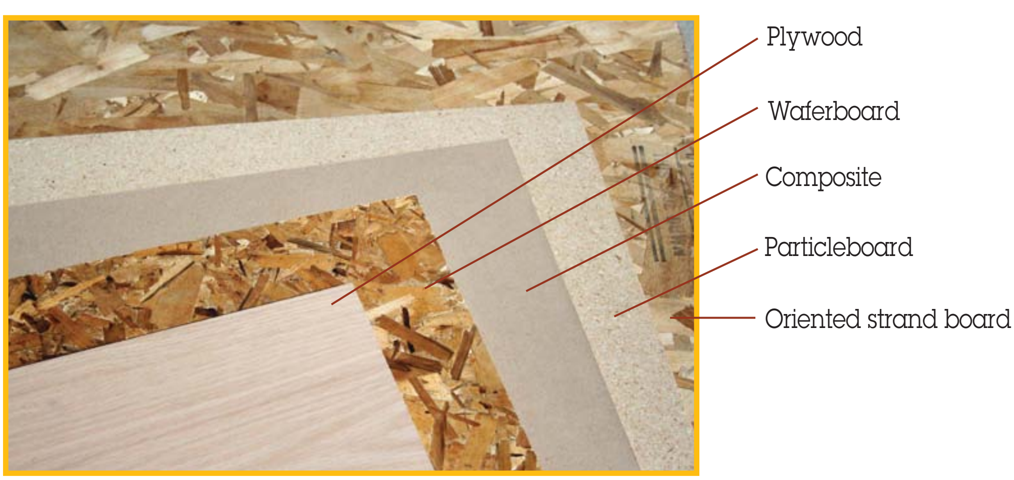
Oriented Strand Board & Waferboard

Most building codes recognize oriented strand board and waferboard for the same uses as plywood, as long as the thicknesses match.

Working with Engineered Panel Products

When working with any engineered panel products, keep the following guidelines in mind:

1. On floors and roofs, run the face grain perpendicular to the supports (except with particleboard, which has no grain). See "Using Engineered Panel Products" illustration.
2. Do not use any piece that does not span at least two supports for floors and roofs.
3. Allow a gap of at least 1/8" on all edges, and a gap of more than 1/8" if the piece will be exposed to a lot of moisture before the siding is installed. Note that this also applies to walls.
4. Follow manufacturers' recommended installation directions.



Engineered Panel Products

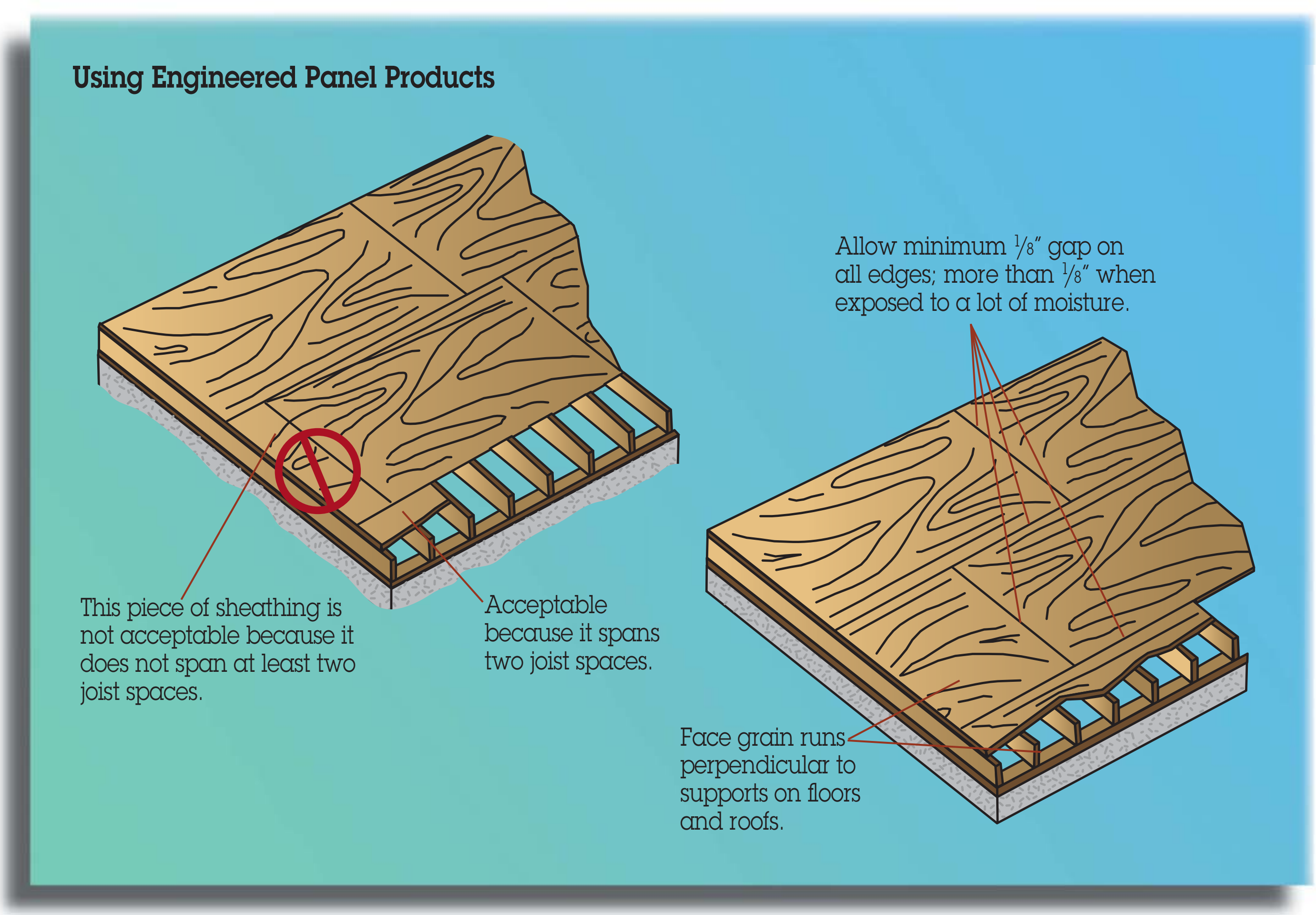
Engineered Lumber Products

I-Joists

I-joists were introduced in 1968 by the Trus Joist Corporation. Although use of this product has grown rapidly over the years, there is still no industry standard for its manufacture and installation. And while the Engineered Wood Association (APA) has established a standard for its members, not all manufacturers are members of APA. Because there is no universal standard, it's important to use the installation instructions that come in the I-joist package. The package is generally prepared by a manufacturer's representative working with the architect or designer.

The I-joist package should include installation plans for the building. These plans will be specific to the building you are working on, and will include a material list and accessories. Accessories can include web stiffeners, blocking panels, joist hangers, rim boards, and beams. The plans typically include a sheet of standard details. The following is a list of elements you'll find in most I-joist packages, and some items to consider when installing them:

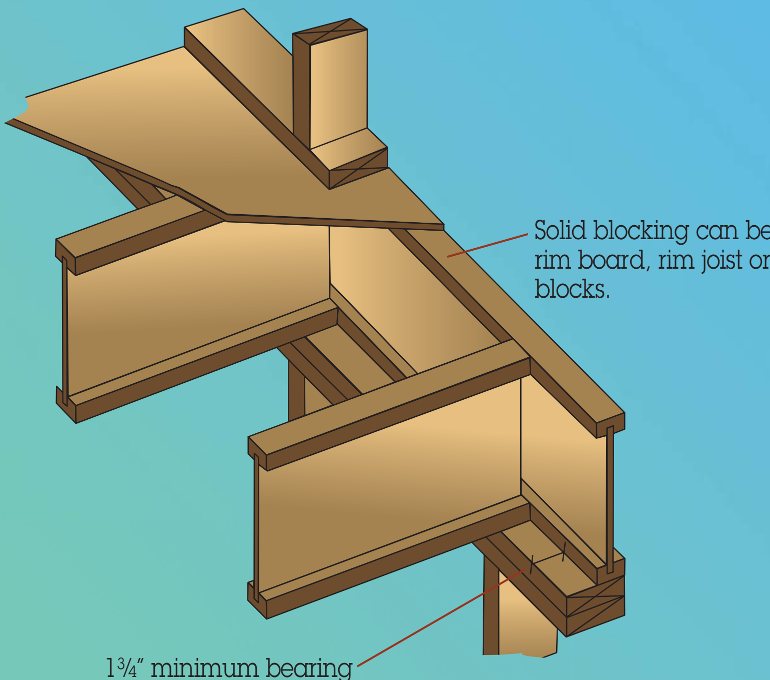
1. **Minimum bearing** is 1¾". (See "Solid Blocking & I-Joist Minimum Bearing" illustration.)
2. **Closure** is required at the end of the I-joist by rim-board, rim-joist, or blocking. This closure also serves to transfer vertical and lateral loads, as well as providing for deck attachment and fireblocking, if required. Do not use dimensional lumber, such as 2 × 10, because it is typically 9¼" instead of 9½". It shrinks much more than the I-joists and will leave the I-joists supporting the load.



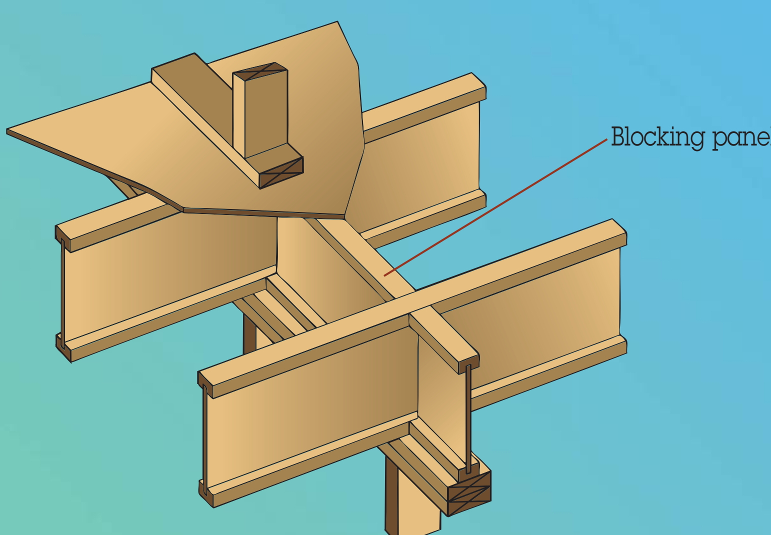
3. **Interior bearing walls** below I-joists require blocking panels or squash blocks when load-bearing walls are above. (See "Interior Bearing WallBlocking Panel" illustration.)
4. **Rim boards** are required to be a minimum of 1¼" in thickness.
5. Make sure **squash blocks**, which are used to support point loads (like the load created by a post), are 1/16" taller than the joists, so that they will properly support the load. (See "Squash Blocks" illustration.)
6. **Web stiffeners**, which are sometimes required at bearing and/or point loads, should be at least 1/8" shorter than the web. Install web stiffeners tight against the flange that supports the load. If the load comes from a wall above, install the web stiffener tight against the top of the flange. If the load comes from a wall below, the stiffener should be installed tight against the bottom. (See "Web Stiffener" illustration.)
7. Use **filler blocking** between the webs of adjacent I-joists to provide load sharing between the joists. (See "Filler Blocking & Backer Blocking" illustration.)
8. **Backer blocking** is attached on one side of the web to provide a surface for attachment of items like face-mount hangers. (See "Filler Blocking & Backer Blocking" illustration.)
9. I-joists are permitted to **cantilever** with very specific limitations and additional reinforcement. If the I-joists are supporting a bearing wall, the maximum cantilever distance with additional reinforcement is 2'. If the I-joists are not supporting a bearing wall, the maximum cantilever is 4'. Check the plans for specifics on the cantilever.
10. **Top-flange hangers** are most commonly used for I-joists. (See "Top Flange Hanger Tight" illustration.) They come with the I-joist package, but you can also get them from a construction supply store. When installing top flange hangers, make sure that the bottom of the hanger is tight against the backer block or the header. When nailing the hanger into the bottom of the joist, be sure to use the correct length nails. Nails that are too long can go through the bottom flange and force the joist up. (See "Use Right Size Nail" illustration.) When installing hangers on wood plates that rest on steel beams, the hanger should not touch the steel. The distance it can be held away from the steel depends on the plate thickness. Note that hangers rubbing against the steel can cause squeaks. (See "Top Flange Hanger Spacing" illustration.)
11. **Face-mount hangers** can be used. Make sure that the hangers are tall enough to support the top flanges of the joists. Otherwise use web stiffeners. (See "Face-Mount Hangers" illustration.) Be sure to use the correct length and diameter of nail.
12. **The bottom flange cannot be cut or notched** except for a bird's mouth. At a bird's mouth, the flange cut should not overhang the edge of the top plate. (See "Bottom Flange I-Joist" illustration.)
13. Leave a 1/16" gap between I-joists and the supporting member when I-joists are placed in hangers. (See "Gap Between I-Joist & Support" illustration.)
14. The **top flange** can be notched or cut only over the top of the bearing and should not extend beyond the width of the bearing. (See "Top Flange I-Joists" illustration.)
15. **The web can have round or square holes.** Check the information provided with the I-joist package. Typically the center of the span requires the least strength and can have the biggest holes. The closer to the bearing point, the smaller the hole should be.
16. **When I-joists are used on sloped roofs**, they must be supported at the peak by a beam. This is different from dimensional lumber, where rafters may not require such a beam.

In working with residential I-joists, you should be aware that the APA has developed a standard for residential I-joists called Performance Rated I-joists (PRI). This standard shows the span and spacing for various uses for marked I-joists. (See "APA Performance Rated I-Joists" illustration.)

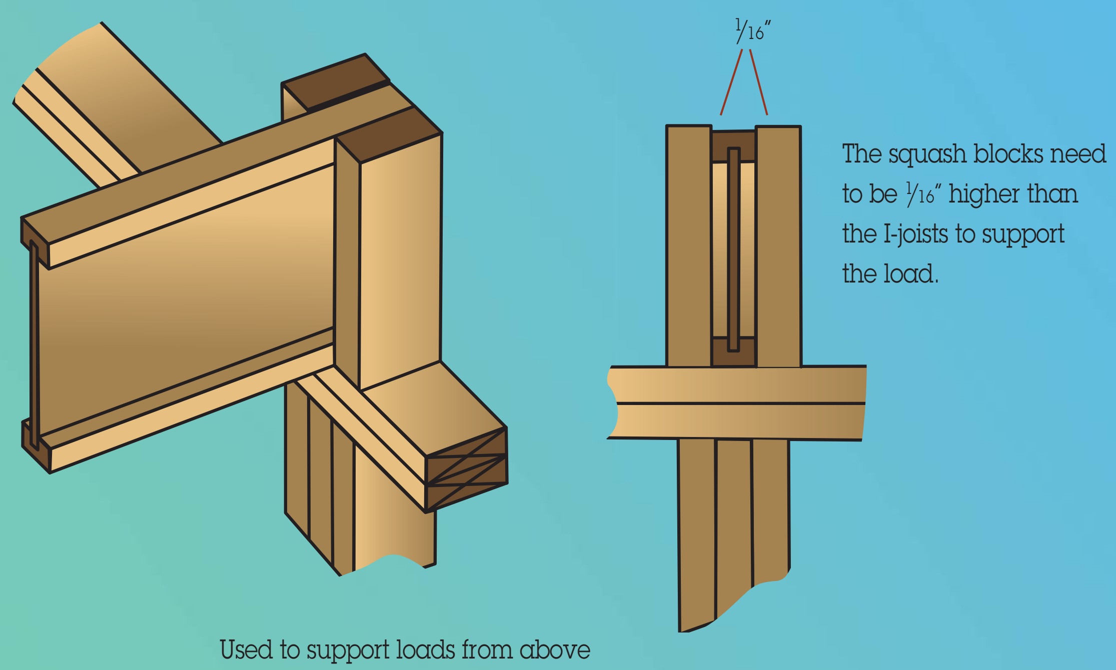
Solid Blocking & I-Joist Minimum Bearing



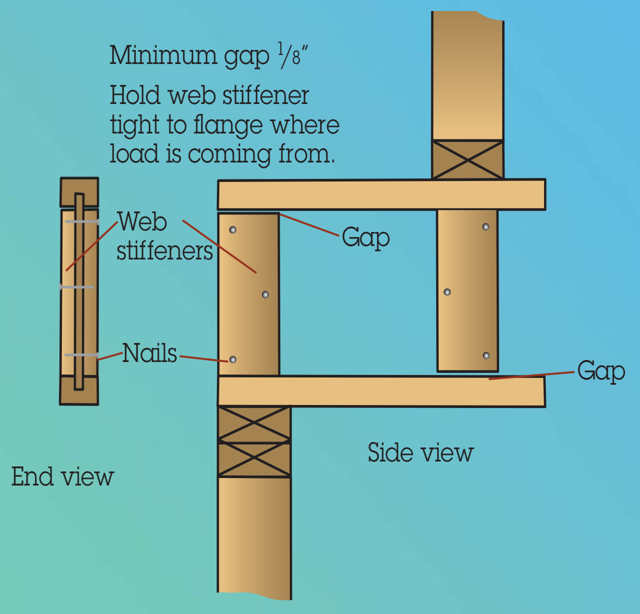
Interior Bearing Wall Blocking Panel



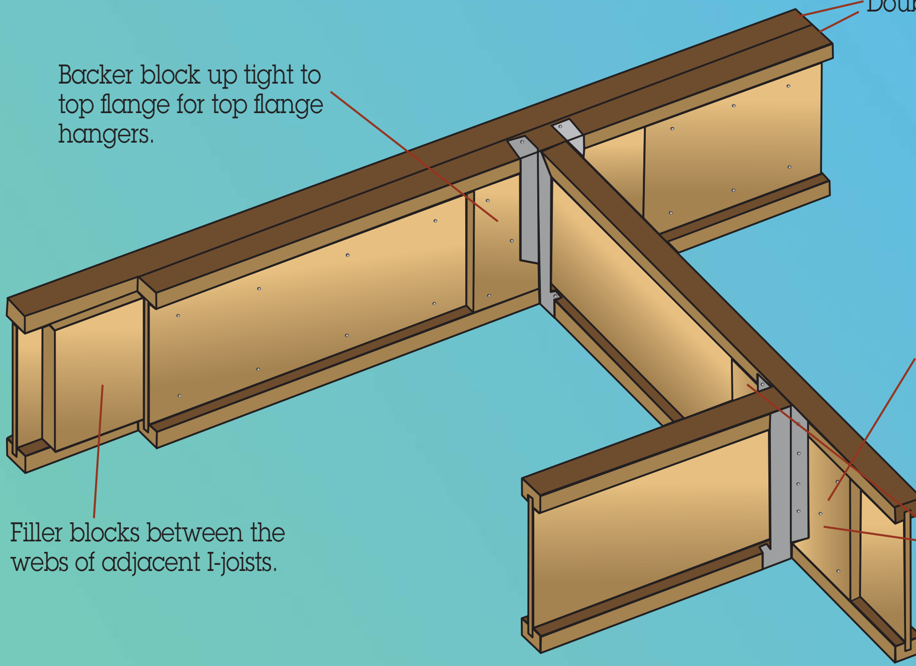
Squash Blocks



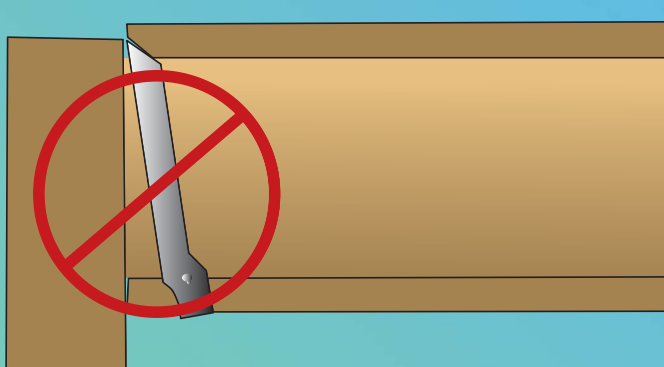
Web Stiffener



Filler Blocking & Backer Blocking

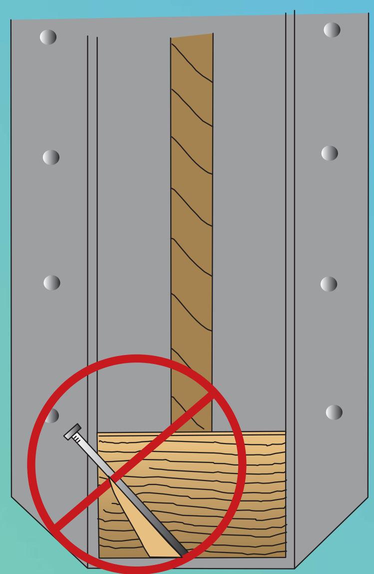


Top Flange Hanger Tight

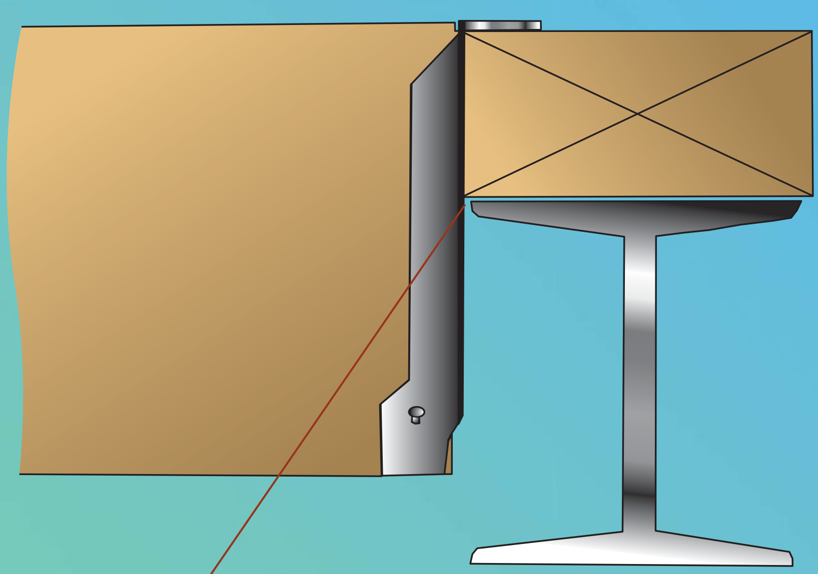


Hanger needs to be tight against header or backer block.

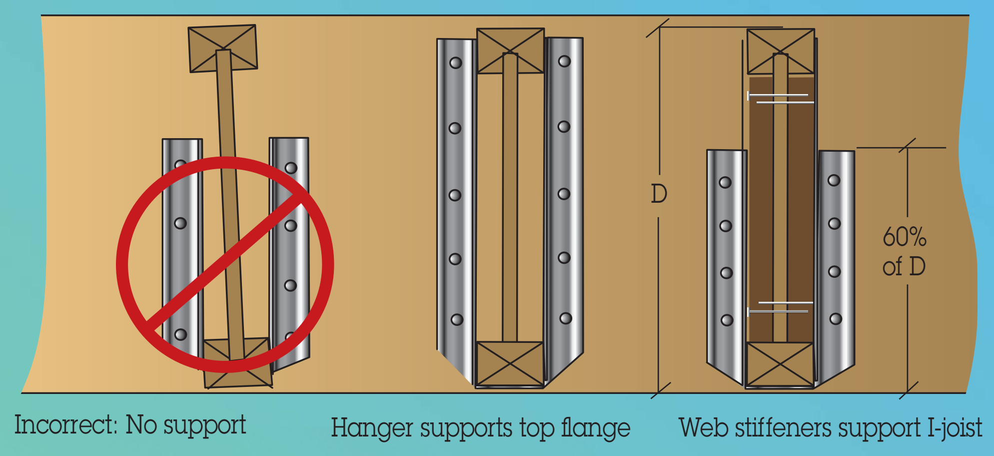
Use Right Size Nail



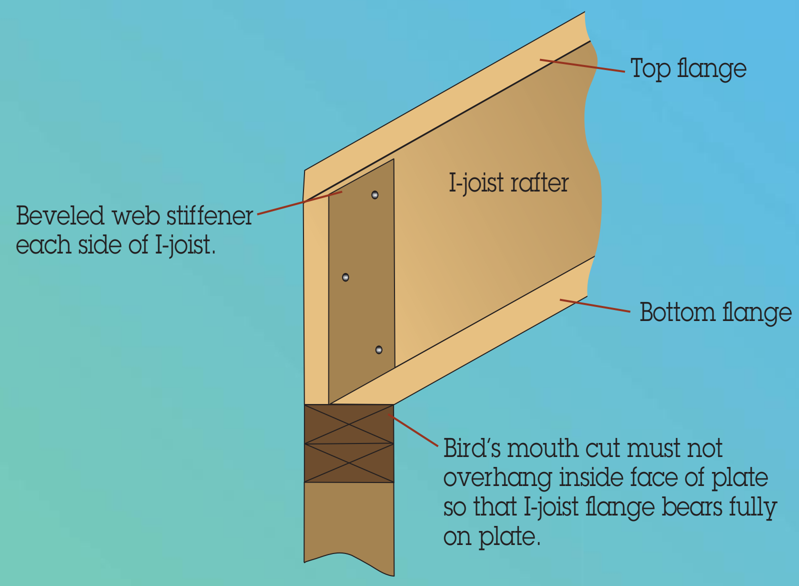
Top Flange Hanger Spacing



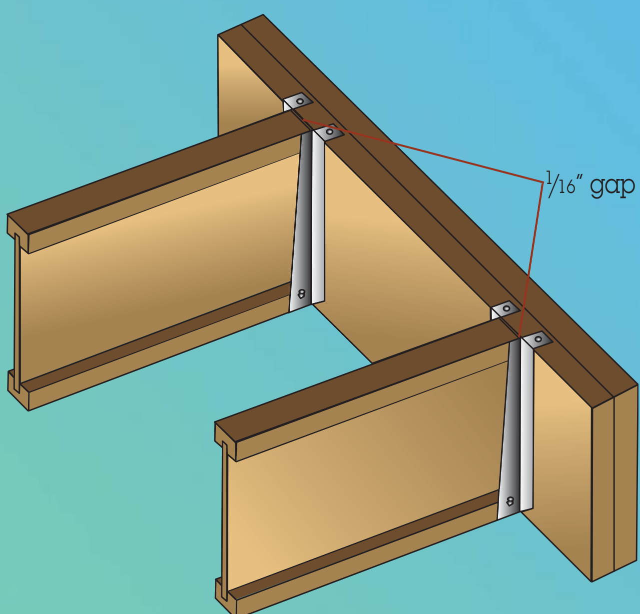
Face-Mount Hangers



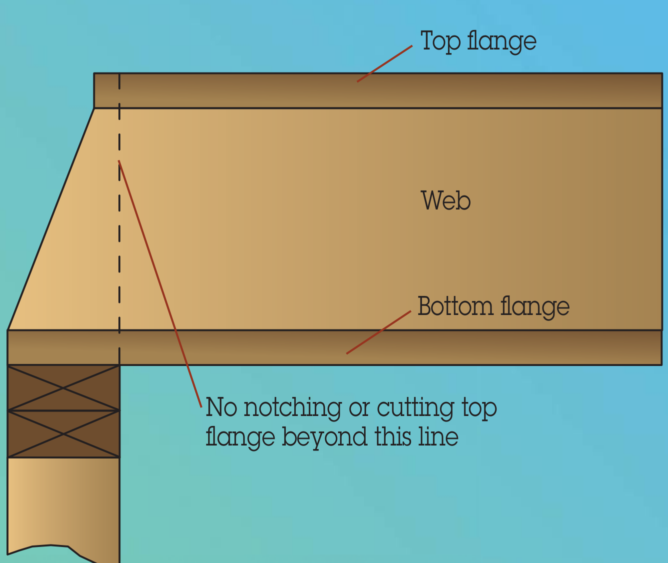
Bottom Flange I-Joist



Gap Between I-Joist & Support

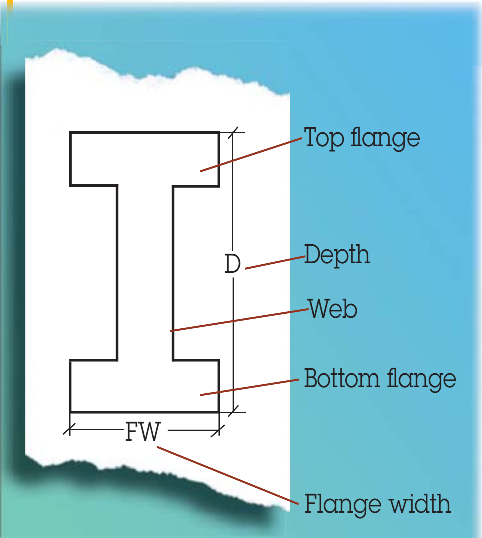


Top Flange I-Joists

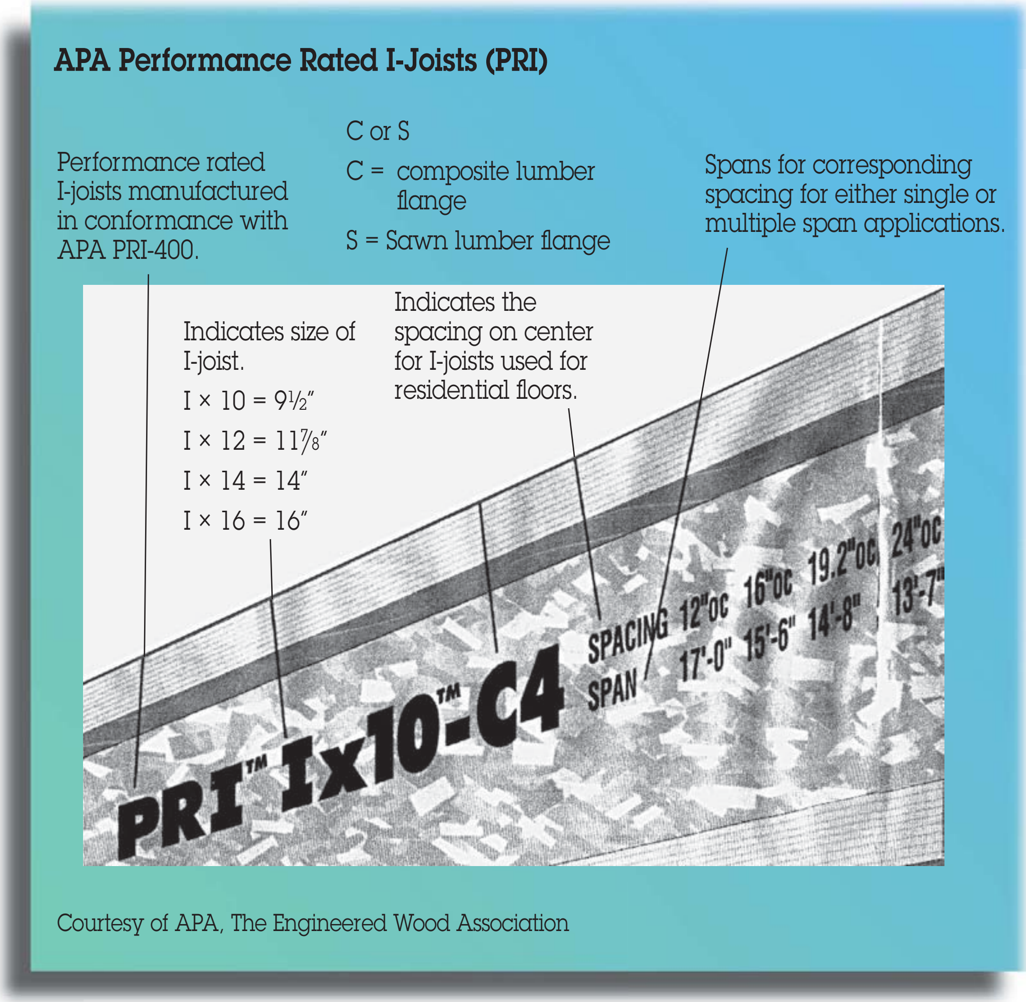


I-Joist Sizes

I-Joists	D (depth)	FW (flange width)
TJI 110	9-1/2", 11-7/8", 14"	1-3/4"
TJI 210	9-1/2", 11-7/8", 14", 16"	2-1/16"
TJI 230	9-1/2", 11-7/8", 14", 16"	2-5/16"
TJI 360	11-7/8", 14", 16", 18", 20"	2-5/16"
TJI 560	11-7/8", 14", 16", 18", 20"	3-1/2"
TJI 560D	18", 20", 22", 24"	3-1/2"
LPI 20 Plus	9-1/2", 11-7/8", 14"	2-1/2"
LPI 32 Plus	9-1/2", 11-7/8", 14", 16"	2-1/2"
LPI 42 Plus	9-1/2", 11-7/8", 14", 16", 18", 20", 22", 24"	3-1/2"
LPI 36	11-7/8", 14", 16", 18", 20", 22", 24"	2-1/4"
LPI 56	11-7/8", 14", 16", 18", 20", 22", 24"	3-1/2"
GPI 20	9-1/2", 11-7/8", 14"	1-3/4"
GPI 40	9-1/2", 11-7/8", 14"	2-5/16"
GPI 65	11-7/8", 14", 16"	2-7/8"
GPI 90	11-7/8", 14", 16"	3-1/2"
WI 40	9-1/2", 11-7/8", 14"	2-1/2"
WI 60	11-7/8", 14", 16"	2-7/8"
WI 80	11-7/8", 14", 16"	3-1/2"
RFPI 20	9-1/2", 11-7/8", 14"	1-3/4"
RFPI 40	9-1/2", 11-7/8", 14", 16"	2-5/16"
RFPI 70	9-1/2", 11-7/8", 14", 16"	2-5/16"
RFPI 90	11-7/", 14", 16"	3-1/2"
RFPI 400	9-1/2", 11-7/8", 14", 16"	2-1/16"
RFPI 40S	9-1/2", 11-7/8", 14", 16"	2-1/2"
RFPI 60S	9-1/2", 11-7/8", 14", 16"	2-1/2"
BCI 5000 1.7	9-1/2", 11-7/8", 14"	2"
BCI 6000 1.8	9-1/2", 11-7/8", 14", 16"	2-5/16"
BCI 6500 1.8	9-1/2", 11-7/8", 14", 16"	2-9/16"
BCI 60 2.0	11-7/8", 14", 16"	2/5/16"
BCI 90 2.0	11-7/8", 14", 16", 18", 20"	3-1/2"
AJS 140	9-1/2", 11-7/8"	2-1/2"
AJS 20	9-1/2", 11-7/8", 14", 16"	2-1/2"
AJS 25	9-1/2", 11-7/8", 14", 16"	3-1/2"
AJS 25 deeper	18", 20", 22", 24"	3-1/2"
Red-145	9-1/2", 11-7/8", 14"-16"	1-3/4"
Red-165	11-7/8", 14"-30"	2-1/2"
Red-190	11-7/8", 14"-30"	3-1/2"
Red-190H	11-7/8", 14"-30"	3-1/2"
Red-190HS	11-7/8", 14"-32"	3-1/2"
		ssf



I-Joist Terminology



Glu-Lam Beams

Glu-lam beams are used when extra strength and greater spans are needed. They are usually big, heavy, and expensive, and require hoisting equipment to set them in place. Most often glu-lam beams are engineered for particular jobs. Glu-lam beams are produced by gluing certain grades of dimensional lumber together in a specific order. Many times the pieces are glued together to create a specific shape or camber. If a camber is created, the top of the beam will be marked. Make sure your crew installs it right-side-up.

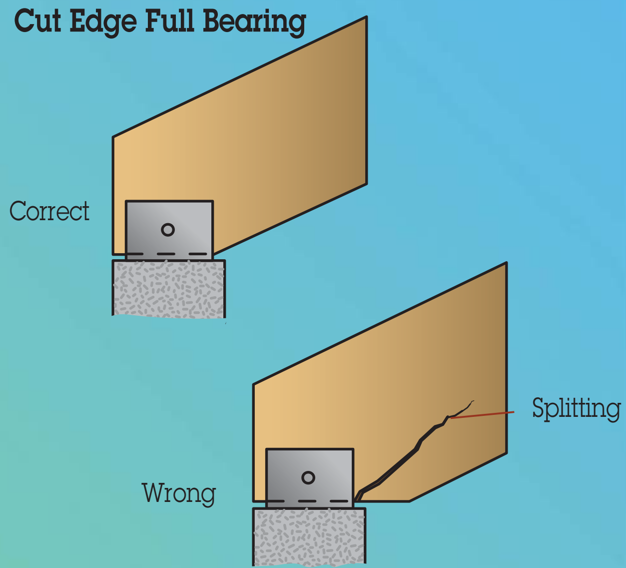
The expense of glu-lam beams and the time required for replacing one makes it very important that they are cut correctly.

Notching & Drilling

The general rule for glu-lam beams is no notching or drilling without an engineer's direction. The engineer who determined the strength needed for the glu-lams is the person who will know how a notch or hole will affect the integrity of the glu-lam beam.

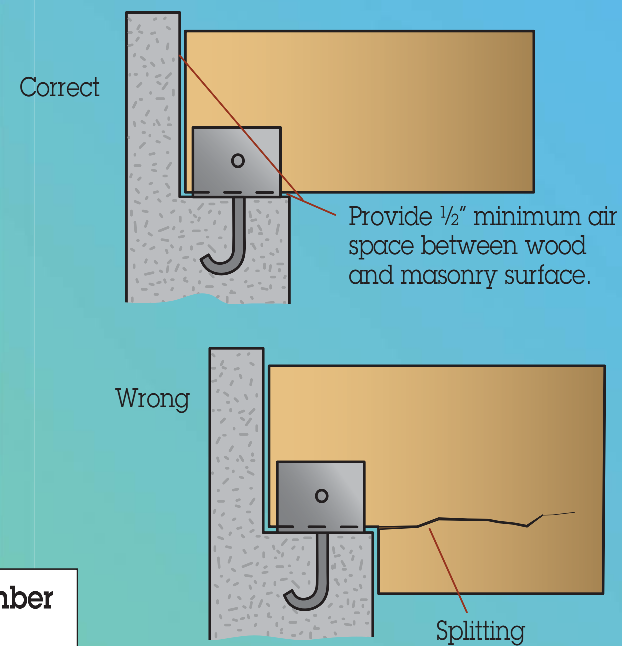
The way glu-lam beam connections are made will affect the strength and integrity of the beams. Following the illustrations are examples of correct and incorrect ways to connect glu-lam beams, and some tips for easy installation.

Cut Edge Full Bearing



Splitting may result from rapid drying due to exposed end grain.

No Notching End of Glu-Lam Beam



Notching at ends of beams can cause splitting at inside corner. A notch at the end of a glu-lam beam should be checked by the engineer.

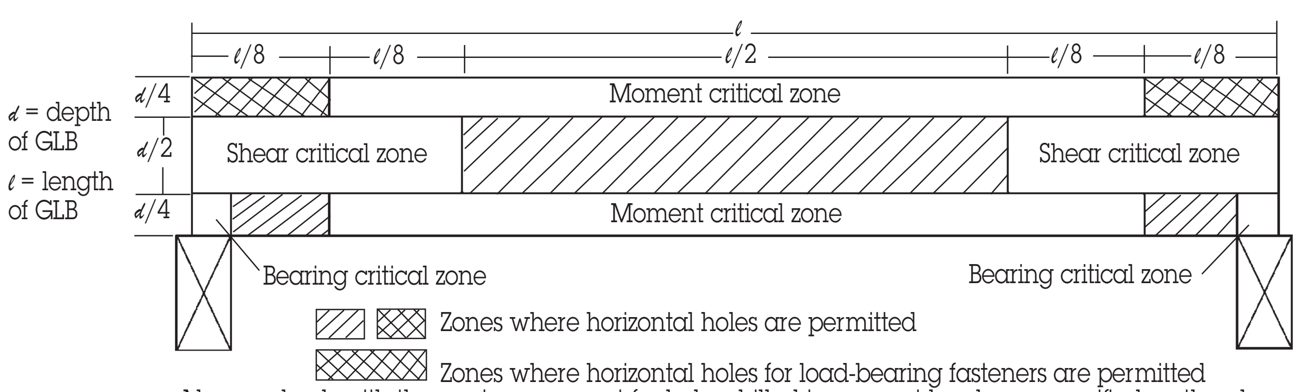
Glued-Laminated Timber Weights for DF-L

Width Depth	3-1/8"	5-1/8"	6-3/4"	8-3/4"	10-3/4"	12-1/4"	14-1/4"
6"	4.6	7.5	9.8	12.8	15.7	17.9	20.8
9"	6.8	1.2	14.8	19.1	23.5	26.8	31.2
12"	9.1	14.9	19.7	25.5	31.4	35.7	41.6
15"	11.4	18.7	24.6	31.9	39.2	44.7	52
18"	13.7	22.4	29.5	38.3	47	53.6	62.3
21"	16	26.2	34.5	44.7	54.9	62.5	72.7
24"	18.2	29.9	39.4	51	62.7	71.5	83.1
27"	20.5	33.6	44.3	57.4	70.6	80.4	93.5
30"	22.8	37.4	49.2	63.8	78.4	89.3	103.9
33"		41.1	54.2	70.2	86.2	98.3	114.3
36"		44.8	59.1	76.6	94.1	107.2	124.7
39"		48.6	64	83	101.9	116.1	135.1
42"		52.3	68.9	89.3	109.7	125.1	145.5
45"		56	73.8	95.7	117.6	134	155.9
48"		59.8	78.8	102.1	125.4	142.9	166.3
51"			83.7	108.5	133.3	151.9	176.7
54"			88.6	114.8	141.1	160.8	187
57"			93.5	121.2	148.9	169.7	197.4
60"			98.4	127.6	156.8	178.6	207.8
63"				134	164.6	187.6	218.2
66"				140.4	172.4	196.5	228.6
69"				146.8	180.3	205.5	239
72"				153.1	188.1	214.4	249.4
75"				159.5	196	223.3	259.8
78"					203.8	232.2	270.3
81"					211.7	241.2	280.5
84"					219.5	250.1	290.9
87"					227.3	259.1	301.4
90"					235.2	268.1	311.8
93"		For weights of HF multiply by .77				276.8	322
96"						285.8	332.5
99"		For weights of SP multiply by 1.03				294.8	343
102"						303.8	353.4
105"						312.6	363.6
108"		This weight chart is a good resource when you need to determine what size boom truck or crane you will need to set your glued-laminated beams				321.6	374.1
111"						330.6	384.5
114"							395
117"							405.2
120"							415.6
123"							426.1
126"							436.5
129"							446.7

Tips for Installing Glu-Lam Beams

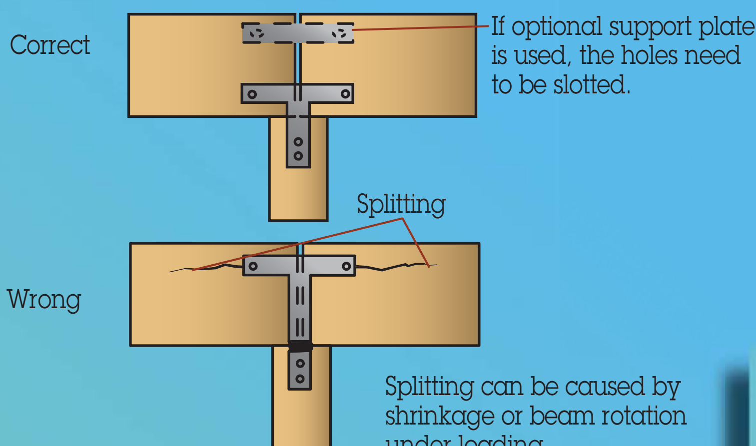
- For glu-lam beams that are installed at a pitch and need to have the bottom cut to be level, make sure that the end of the bottom cut closest to the bearing edge receives full bearing. (See "Cut Edge Full Beaning" illustration.)
- Ends of beams should not be notched unless approved by the engineer. (See "No Notching End of Glu-Lam Beam" illustration.)
- Glu-lam beams will shrink as they dry out. If the top of the beam is connected in a way that doesn't allow for shrinkage, the glu-lam beam will split. (See "Glu-Iam Beam Shrinkage" illustration.)
- When a lateral support plate is used to connect two glu-lam beams, the holes should be slotted horizontally to prevent splitting. (See "Lateral Support Plate" illustration).
- Glu-lams are also used for posts. It is important to keep them away from concrete, which contributes to their decay. Placing a steel shim under the beam will keep it from touching the concrete. (See "Decay Prevention Next to Concrete" illustration.)
- Hinge connectors should be installed so that they don't cause splitting of the glu-lam beams. This can be done by using a strap that is independent of the hinge connector, or by vertical slotting the holes in a strap that is connected to the hinge connector. (See "Hinge Connector Slotted Holes" illustration.)
- Glu-lam beams rest on metal post caps that often have a weld or radius in the bottom corner. If you don't ease the bottom corners of the beam, the beam will sit up in the pocket. Often, the glu-lam beam's bottom corners are already rounded and won't need attention.
- In some cases, the sides of the metal post caps are bent in so that the beams will not slide in properly. Check all the sides of the metal post caps before they are installed, so you won't have a forklift or boom truck and crew standing around waiting while someone labors on top of a ladder to widen the sides of the post cap. (See "Forklift setting glu-lam beams" photograph later in this chapter.)
- Glu-lam beams are often attached to metal caps with bolts. The holes can be drilled either before or after setting the glu-lam beams. If the holes are drilled after the beams are set, use a drill with a clutch. It's easy to break a wrist or get thrown from a ladder when a ½" drill motor without a clutch gets caught on the metal.

Glu-Lam Beam Strength

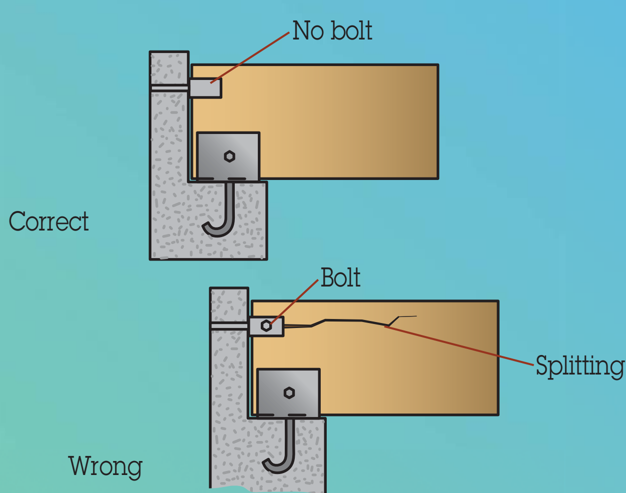


Always check with the engineer, except for holes drilled to connect hardware specified on the plans.

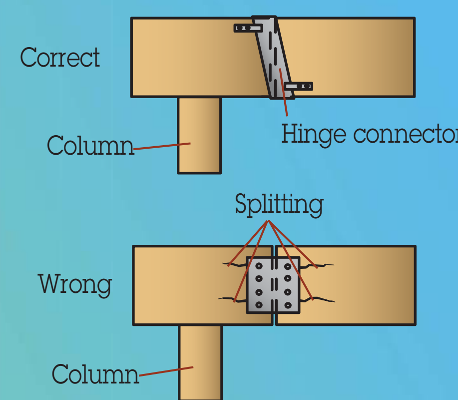
Glu-lam Beam Shrinkage



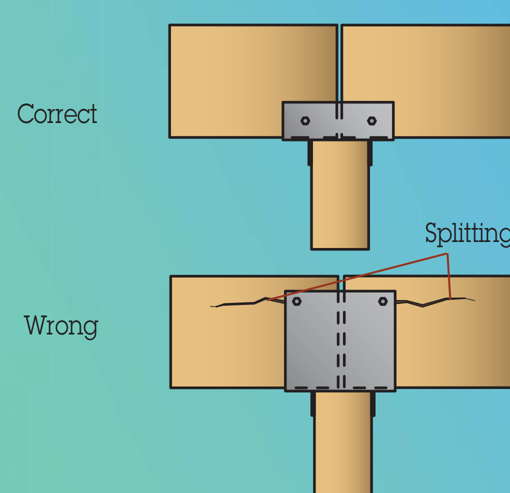
Splitting can be caused by shrinkage or beam rotation under loading.



Top bolt prevents shrinking and causes splitting. Splitting can also occur from limiting beam end rotation as the beam deflects under load.

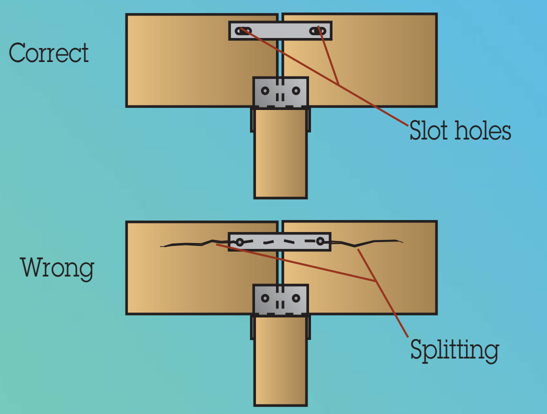


Splitting can be caused by shrinkage on large splice plates.



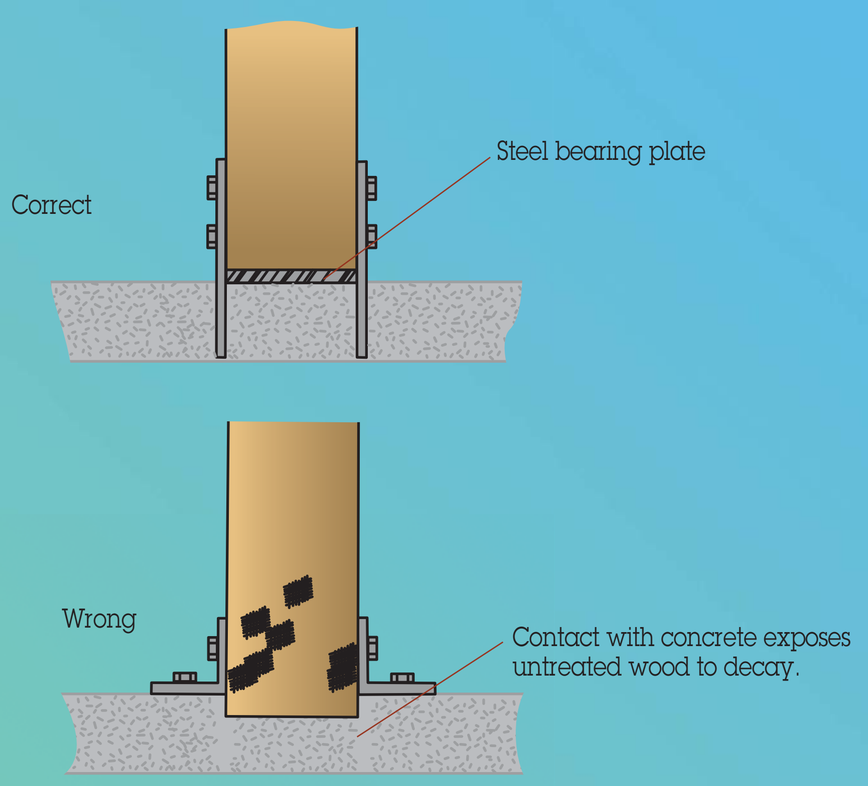
Shrinking or beam rotation due to deflection under loading can cause splitting.

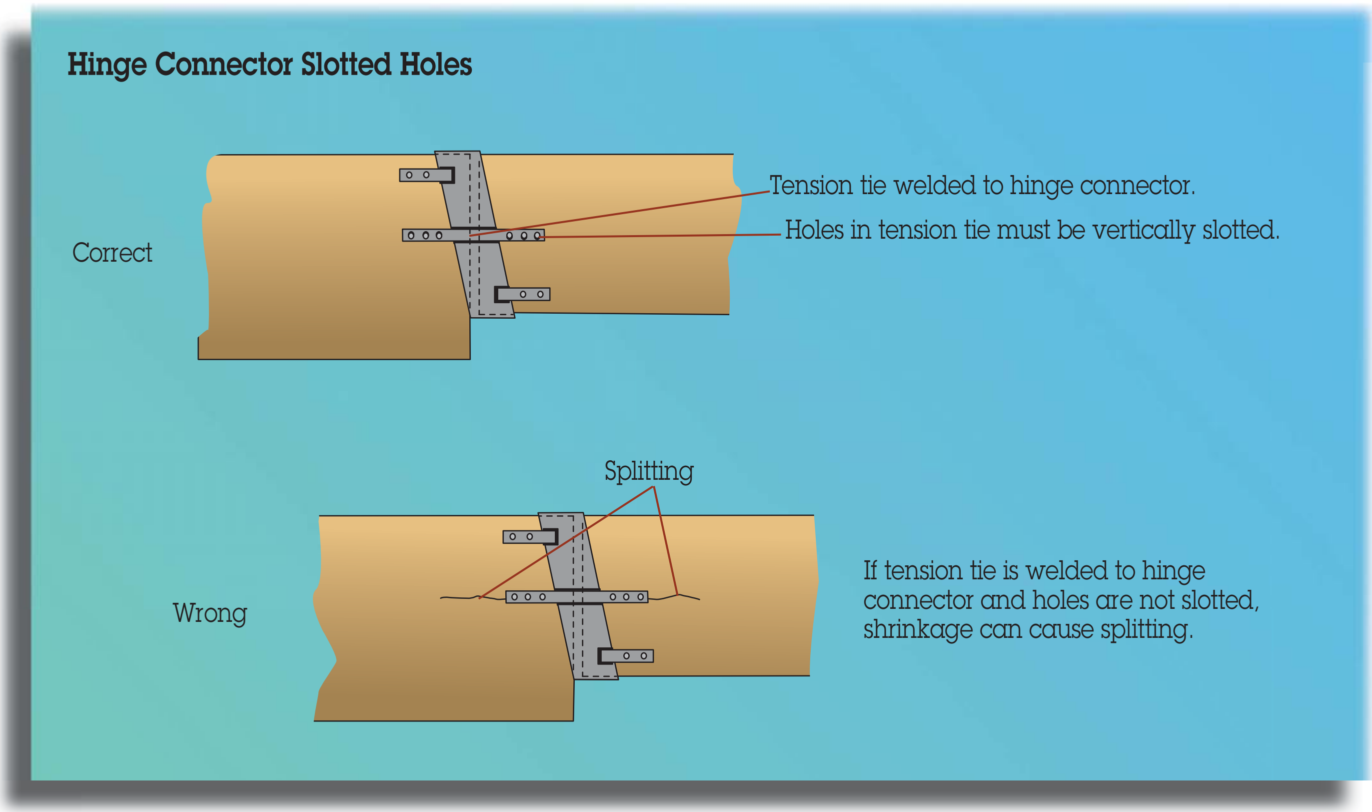
Lateral Support Plate

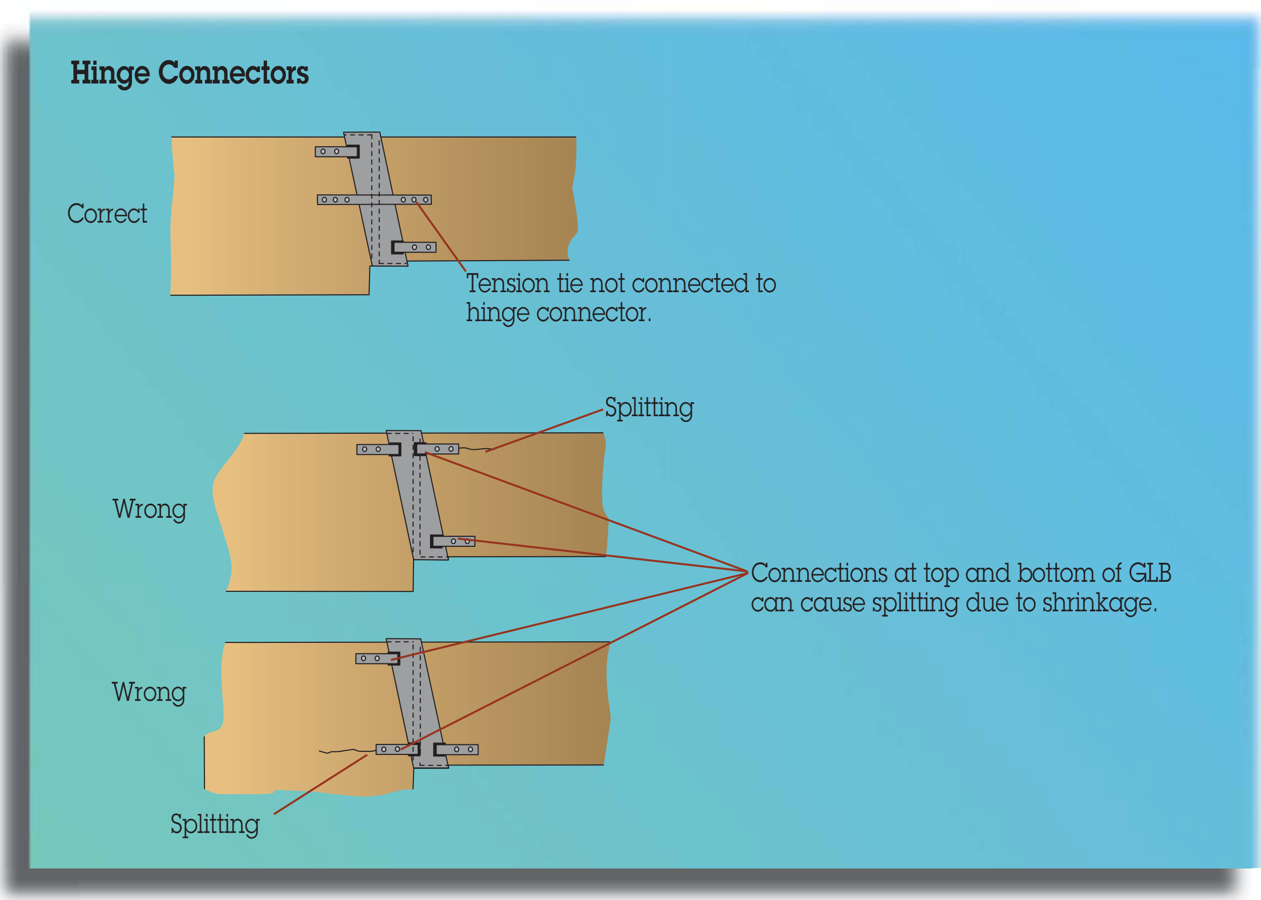


If holes are not slotted, splitting may occur due to beam rotation as the beam deflects under load.

Decay Prevention Next to Concrete




Hinge Connector Slotted Holes
Correct
Tension tie welded to hinge connector.
Holes in tension tie must be vertically slotted.
Splitting
Wrong
If tension tie is welded to hinge connector and holes are not slotted, shrinkage can cause splitting.


Hinge Connectors
Correct
Tension tie not connected to hinge connector.
Splitting
Wrong
Connections at top and bottom of GLB can cause splitting due to shrinkage.
Wrong
Splitting

Metal Plate-Connected Wood Trusses

Metal plate-connected (MPC) wood trusses were first used in the early 1950s. Today they are used in more than 75% of all new residential roofs. Basically they are dimension lumber engineered and connected with metal plates. Less expensive than alternative roof systems, these trusses can also span longer distances. The "Pitched Truss Parts" illustration shows the parts of a single pitched truss on the next page.

Because MPC trusses are engineered products, they should never be cut, notched, spliced, or drilled without first checking with the designing engineer.

Building codes require that a truss design drawing be delivered to the job site. The drawings must show, among other things, the layout locations and bracing details. Note that these drawings are typically not made with framers in mind, so it might take some study time to figure out where the engineer wants the braces. The bracing details often show the braces as small rectangles running laterally between the trusses. See "Lateral Truss Bracing" illustration later in this chapter.

When flying trusses, you should attach the cables around the panel points. When the trusses are greater than 30', a spreader bar should be used. The cables should toe inward to prevent the truss from buckling. If the truss is longer than 60', you will need a strongback temporarily attached to the truss to stabilize it. (See "Flying Trusses" illustration, later in this chapter.)

If you have multiple trusses, you can build a sub-assembly of several trusses on the ground with cross braces and sheathing, then erect them together.

When trusses sit on the ground, on the building, or in place for any length of time, keep them as straight as possible. They are more difficult to set in place and to straighten if they have not been stored properly on site.

Structural Composite Lumber (SCL)

Structural composite lumber (SCL) is an engineered wood product that combines veneer sheets, strands, or small wood elements with exterior structural adhesives. The most common of these products are laminated veneer lumber (LVL), parallel strand lumber (PSL), and laminated strand lumber (LSL). Their names pretty well describe the differences between them.

Like other engineered products, structural composite lumber requires that you follow the engineered specifications that will appear on the plans. Sometimes the specifications simply indicate the use of a particular piece of SCL in a particular location. For larger jobs, you will find the SCL requirements called out in the shop drawings or the structural plans.

Because these are engineered products, you must consult the design engineer before you can drill or notch. Some manufacturers provide guidelines for drilling and notching, but this is not typical.

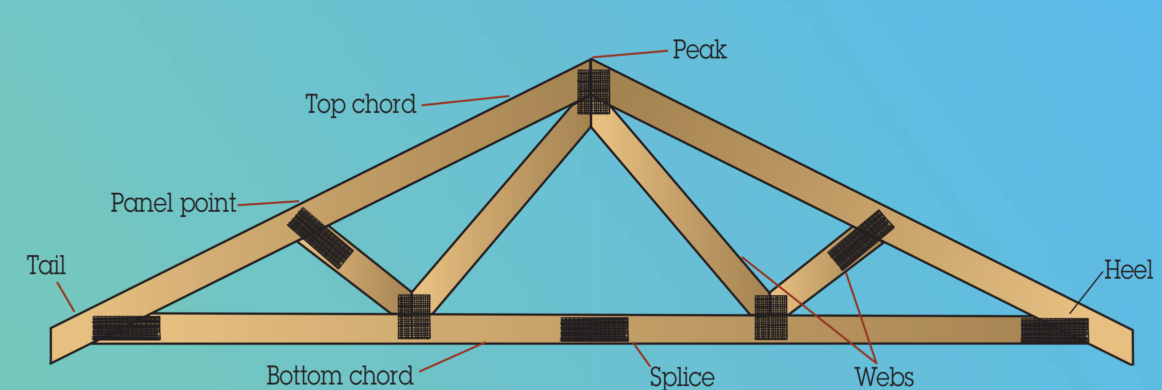
SCL has the advantages of dimensional consistency, stability, and availability of various sizes. It is important to note, however, that where dimensional lumber 4 × 10s, 4 × 12s, etc. can shrink significantly, SCLs have minimal shrinkage. The engineer should allow for this in the design so that you will not have to consider this factor when using SCLs as the plans specify.

Note that SCL studs are becoming common in building tall walls. They provide a degree of straightness that dimensional lumber does not. Although they are heavy and, as a result, not so easy to work with, they make nice, straight walls.

Conclusion

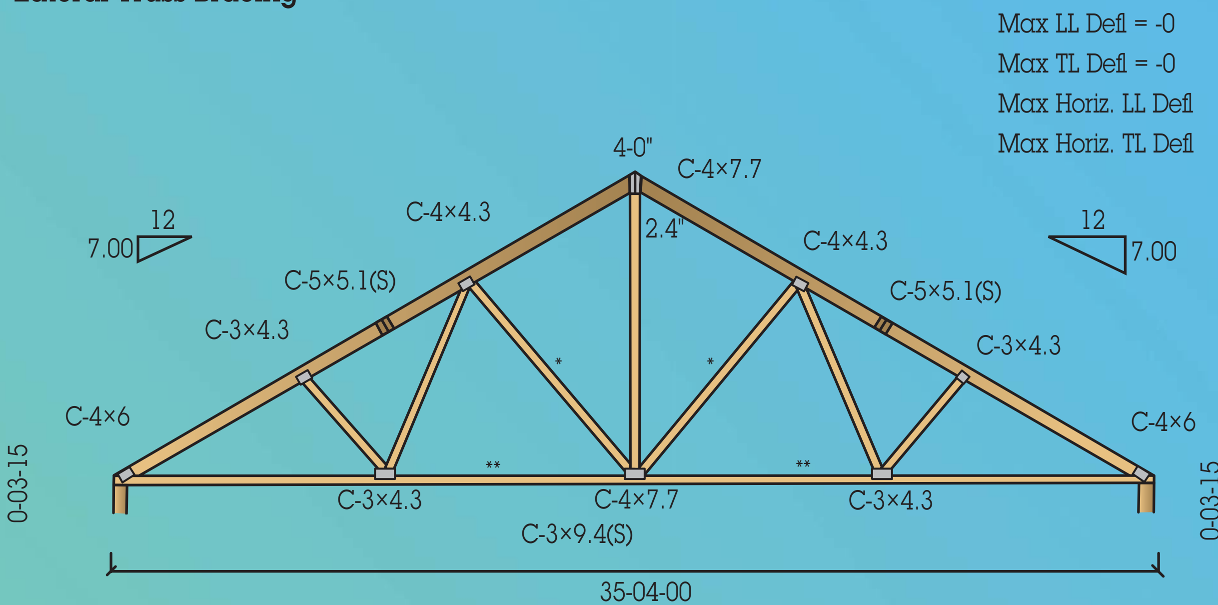
Engineered wood products come in a variety of forms. Becoming familiar with these products is important if you plan to work with them. Always be sure to follow manufacturers' directions, and always consult an engineer if you plan to cut, notch, or drill engineered wood product components.

Forklift setting glu-lam beams



Pitched Truss Parts

Lateral Truss Bracing



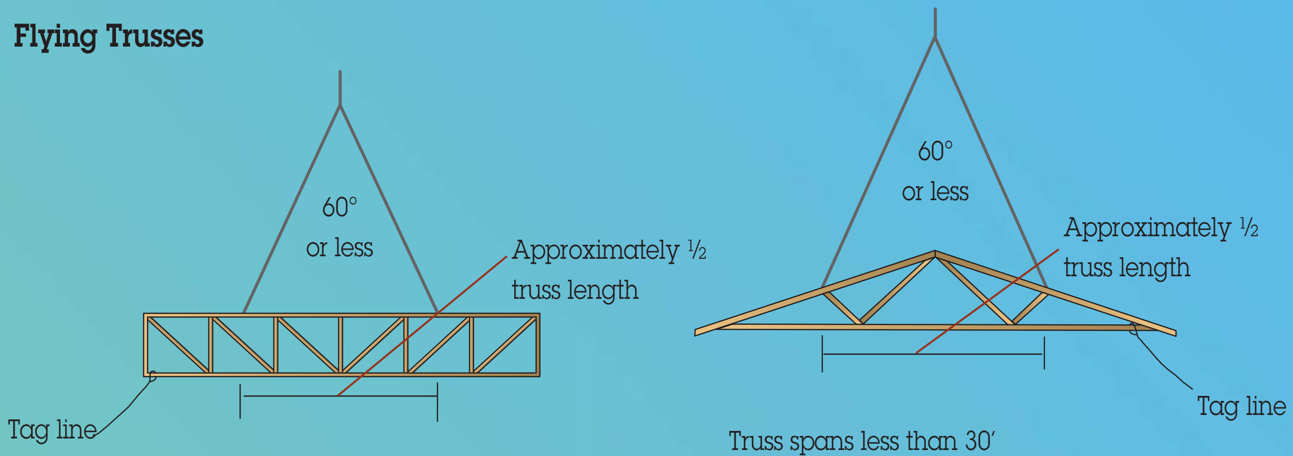
Scale: 3/16"

Job name: - TR-1A

* Denotes 1×4 Lateral OA 2× "T" Web Bracing (by others)

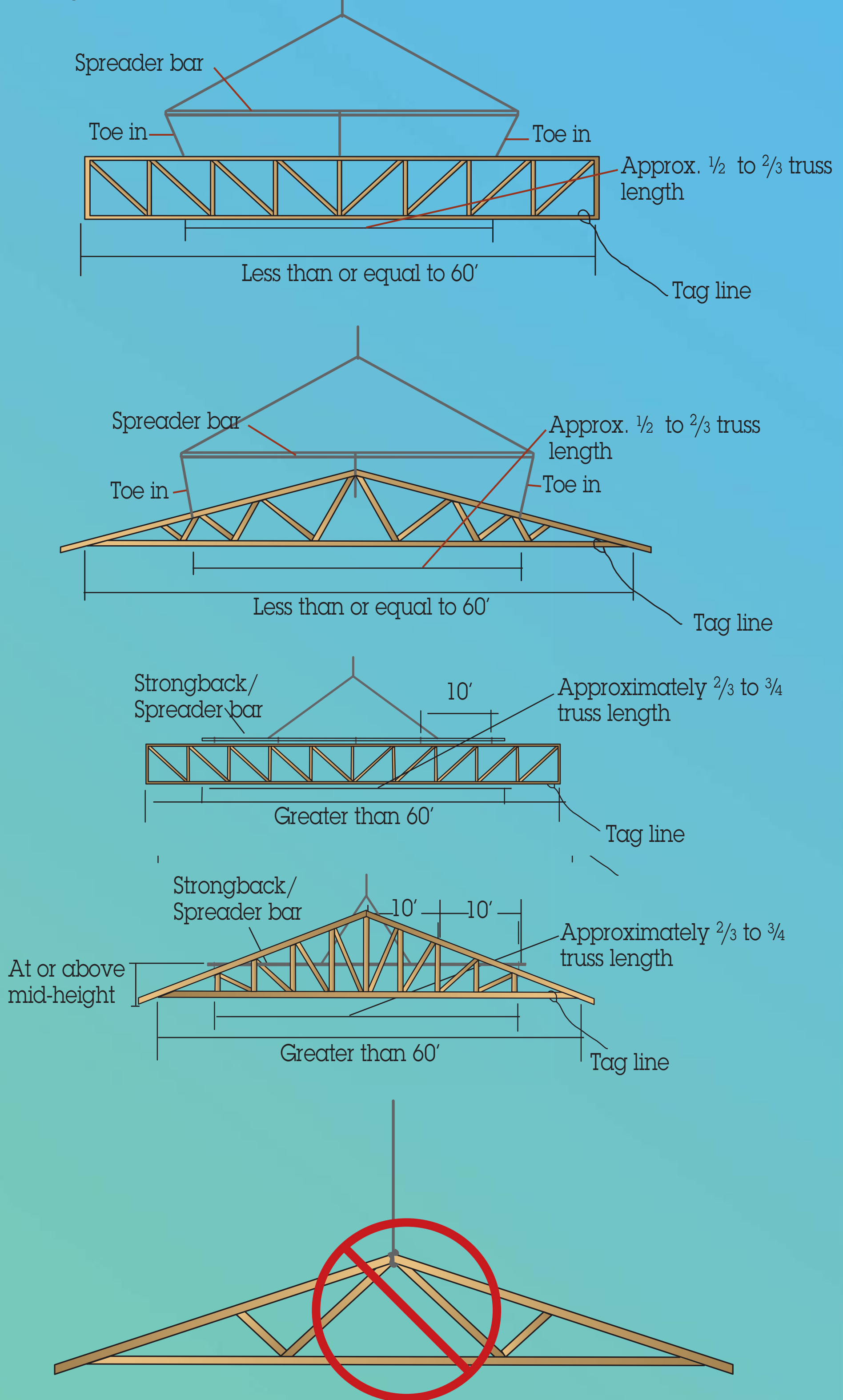
** Denotes 2×4 Lateral Bottom Chord Bracing (by others)

Flying Trusses



Lifting devices should be connected to the truss top chord with a closed-loop attachment using materials such as slings, chains, cables, nylon strapping, etc. of sufficient strength to carry the weight of the truss. Each truss should be set in proper position per the building designer's framing plan and held with the lifting device until the ends of the truss are securely fastened and temporary bracing is installed.

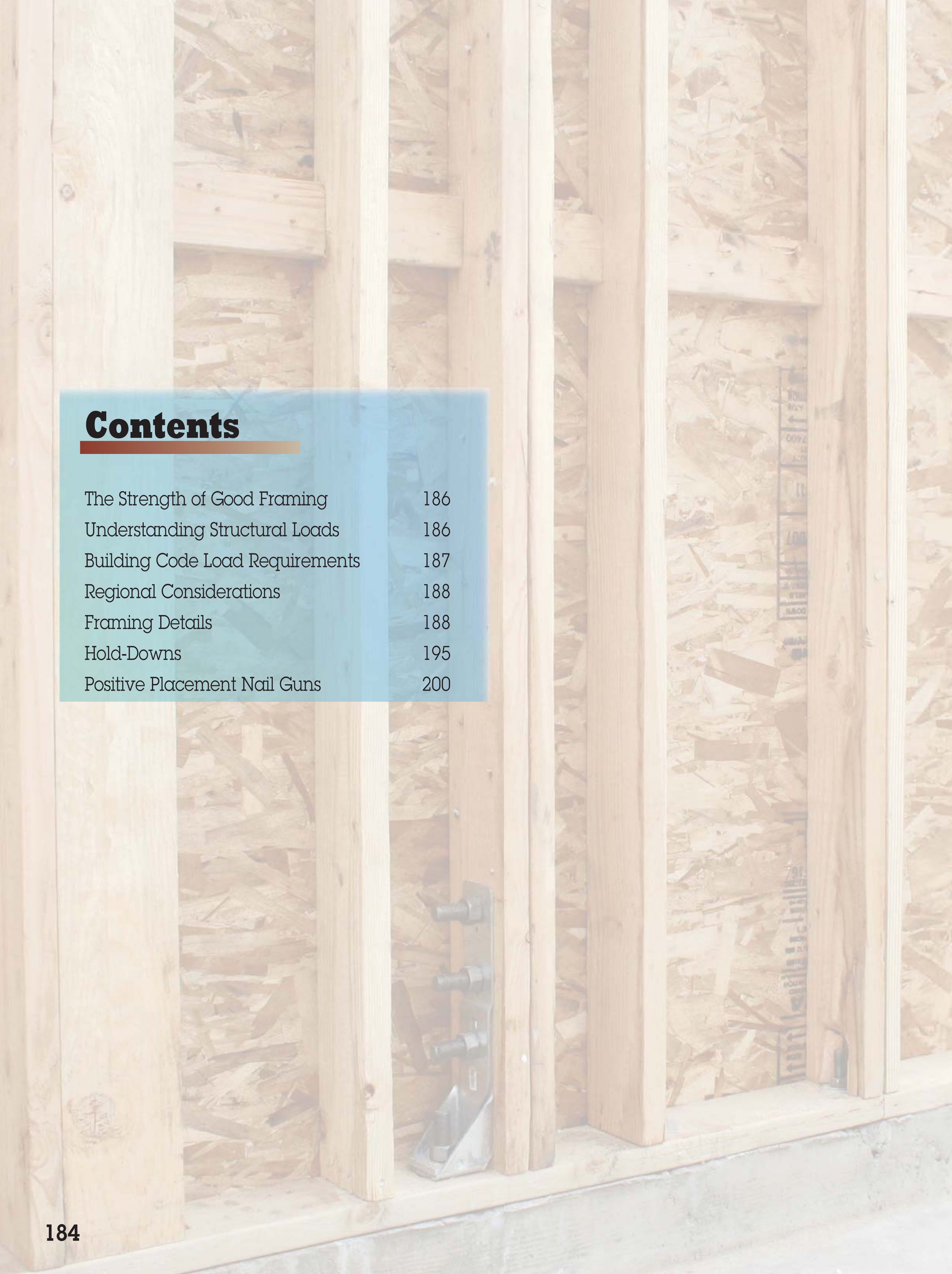
Flying Trusses *(continued)*



Glu-lam Beam Weight Chart

Weight Per Lineal Foot							
GLB	Width	3-1/2"	5"	5-1/4"	7"	9"	11"
# of 2x's	GLB Depth						
4	**6-1/2"**	6.98	7.67	8.05	10.8	13.8	
5	**8-1/8"**	6.23	9.59	10.1	13.4	17.2	
6	**9-3/4"**	7.48	11.5	12.1	16.1	20.7	
7	**11-3/8"**	8.72	13.4	14.1	18.8	24.2	29.5
8	**13"**	9.97	15.3	16.1	21.5	27.6	33.8
9	**14-5/8"**	11.2	17.3	18.1	24.2	31.1	38
10	**16-1/4"**	12.5	19.4	20.1	26.8	34.5	42.2
11	**17-7/8"**	13.7	21.1	11.2	29.5	38	46.4
12	**19-1/2"**	15	23	24.2	32.2	41.4	50.6
13	**21-1/8"**		24.9	26.2	34.9	44.9	54.8
14	**22-3/4"**		26.9	28.2	37.6	48.3	59.1
15	**24-3/8"**		28.8	30.2	40.3	51.8	63.3
16	**26"**		30.7	32.2	43	55.2	67.5
17	**27-7/8"**		32.6	34.2	45.6	58.7	71.7
18	**29-1/4"**		34.6	36.2	48.3	62.1	75.9
19	**30-7/8"**		36.5	38.2	51	65.6	80.2
20	**32-1/2"**				53.7	69	84.4
21	**34-1/8"**				56.4	72.5	88.6
22	**35-3/4"**				59.1	75.9	92.8
23	**37-3/8"**				61.7	79.4	97
24	**39"**				64.4	82.8	101
25	**40-5/8"**				67.1	86.3	105
26	**42-1/4"**				69.8	89.7	110
27	**43-7/8"**					93.2	114
28	**45-1/2"**					96.6	118
29	**47-1/8"**					100.1	122
30	**48-3/4"**					103.6	127
31	**50-3/8"**					107	131
32	**52"**					110.4	135
33	**53-5/8"**					113.9	139

Chapter Nine
WIND & EARTHQUAKE FRAMING



Contents

The Strength of Good Framing 186
Understanding Structural Loads 186
Building Code Load Requirements 187
Regional Considerations 188
Framing Details 188
Hold-Downs 195
Positive Placement Nail Guns 200

Chapter Nine

WIND & EARTHQUAKE FRAMING

Buildings are naturally affected by the forces of nature, and also by artificial forces. Elements such as gravity, wind, snow, earthquakes, retained soil, water, impact by an object, and mudslides can all have negative effects on a building.

This chapter will give you a basic understanding of the forces that affect buildings, and some helpful information on the framing methods used to resist those forces.

Although you may not be responsible for designing structural requirements for buildings, it is important to have some understanding of a building's structural loads. When you are aware of the reasons behind the decisions engineers and architects make, it is easier to interpret the plans, and to make sure that the structure is built accordingly.

The Strength of Good Framing

The forces of nature can have devastating effects on buildings. The following photo shows an example of how destructive the elements can be. This photo is quite dramatic; you can see that the ground literally fell out from under the house. But the photo also shows the strength of good framing—the house stayed together even though the ground collapsed under it.

Source: APA, The Engineered Wood Association

The house stayed together even as the ground fell from under it.

Understanding Structural Loads

As the forces of nature contact a building, they travel throughout seeking a weak link. Ultimately, if a weak link is not found, the force or energy will be transferred to the ground, which will absorb the force. Each component of the building must be strong enough to transfer the load in a path to the ground. The components are:

- Foundations
- Walls
- Floors
- Roofs
- Connections

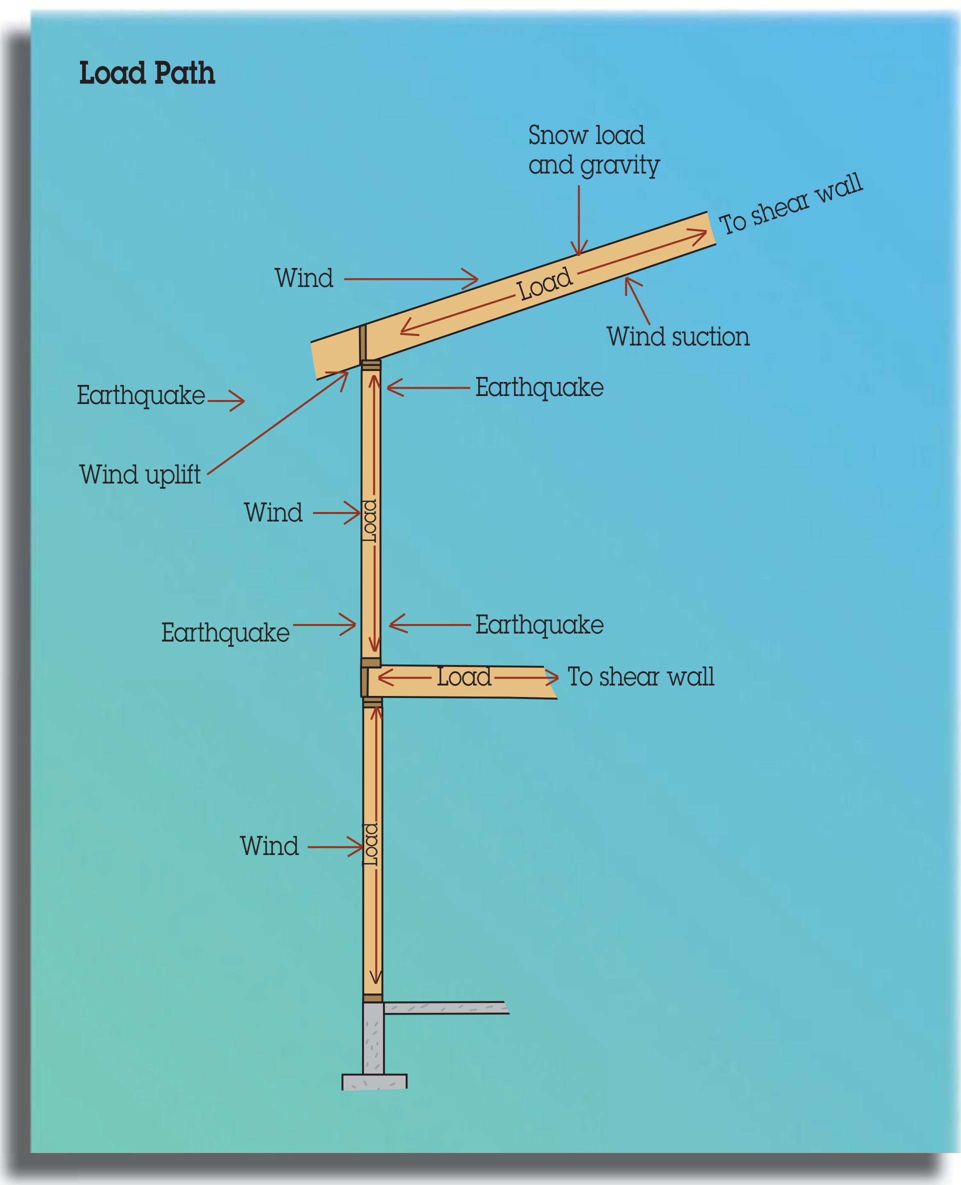
To achieve the strength needed, a building's walls, floors, and roof must work together as a unit. The vertical elements that are used to resist forces are commonly called **shear walls**, and the horizontal elements (like floors and roofs) are called **diaphragms.** The path of energy to the ground is called the **load path.** The diagram on the next page shows the load path for transferring the forces to the ground.

Building Code Load Requirements

Conventional and *nonconventional* codes regulate the strength needed in the walls, floors, roofs, and connections to resist the forces on buildings. The conventional code describes a *prescriptive* standard to resist the forces. The standard applies to simple buildings using common construction methods. The nonconventional code is a performance-rated system and provides *non-prescriptive* engineering guidelines that can be applied to more unusual or more difficult buildings.

Prescriptive Format

The prescriptive format has specific requirements, such as the size of studs needed or the type of wall bracing. If you build the structure following these requirements, then the building meets the minimum code standards for a safe building. The prescriptive codes are covered in more detail in Chapter 10.

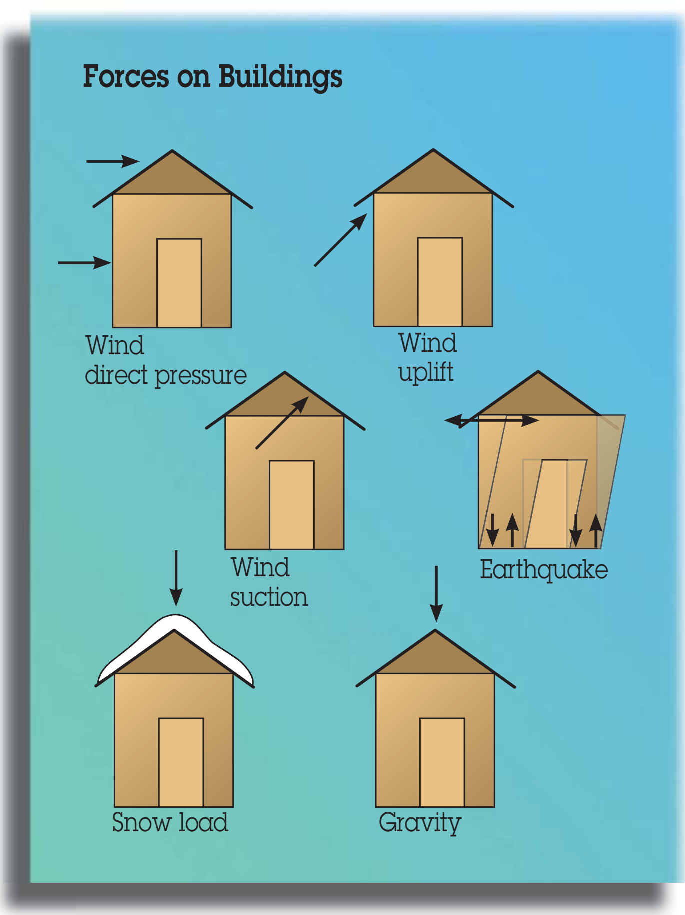


Framers meet prescriptive code requirements on a regular basis, sometimes without even knowing it. As they brace their walls, block and nail their floor system, nail their walls to the floors, and bolt the building to the foundation, they are creating a load path that transfers the forces of nature to the ground—in ways that are prescribed by the code.

Non-Prescriptive Code

The performance, or non-prescriptive, code provides for free design, as long as it stays within certain code standards. Performance designing is different for each building, and the engineer or architect must specify and detail all aspects of the design.

A special design might be needed because a building is in a high-earthquake or a high-wind zone, because it requires large open spaces or window walls, or to resist other forces. The most common forces affecting buildings are shown in the illustration "Forces on Buildings."



Regional Considerations

Different forces affect buildings in the various parts of the country. Builders have to worry about earthquakes in California, high winds in Florida, and snow loads in Colorado. It's easier to understand the architect's or engineer's plans if you are aware of these factors. The following maps give you an idea of some of the areas of the country that suffer most from the effects of earthquakes, winds, and snow loads.

Framing Details

The most common framing details can be broken down into three categories.

- Shear wall construction
- Diaphragm construction
- Connections

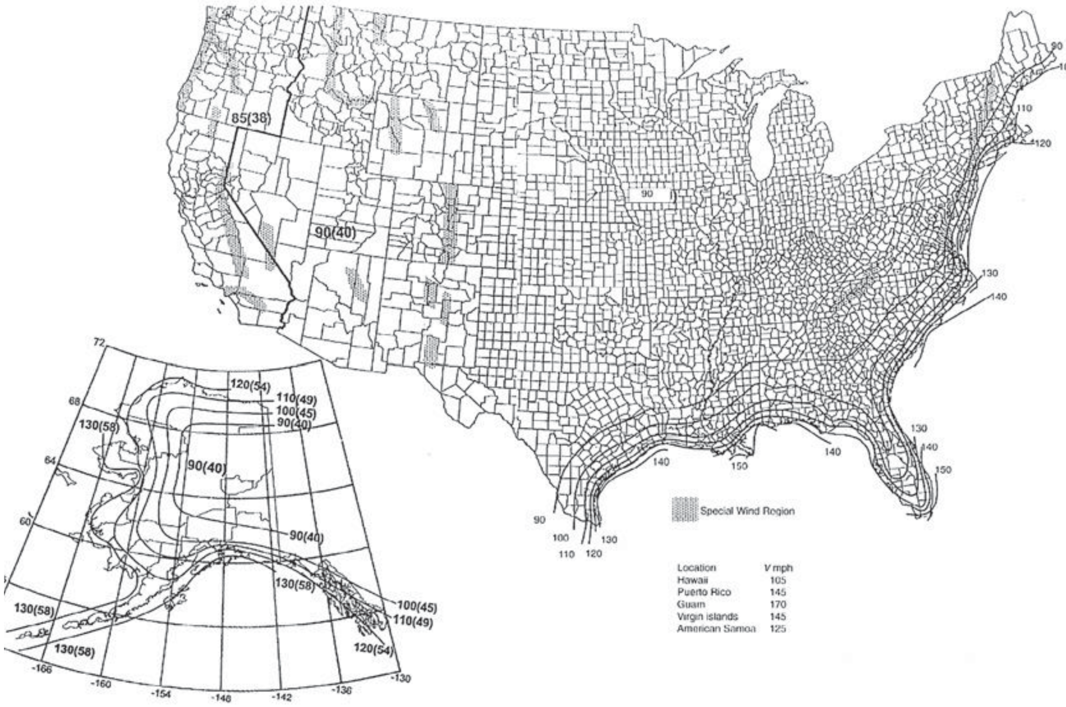
Each of these categories is covered in this section, including important points for framing.

Shear Wall Construction

The factors that affect the strength of any shear wall are:

- The size and type of material used for the plates and studs.
- The size and type of material used for the sheathing.
- Whether one side or both sides have sheathing.
- The nail sizes and patterns.
- Whether or not there is blocking for all the edges of the sheathing.

Engineers and architects are free to use any system they prefer, as long as they can prove that it meets the minimum strength requirements. The easiest and most common method is using the code book tables that provide accepted values for walls with

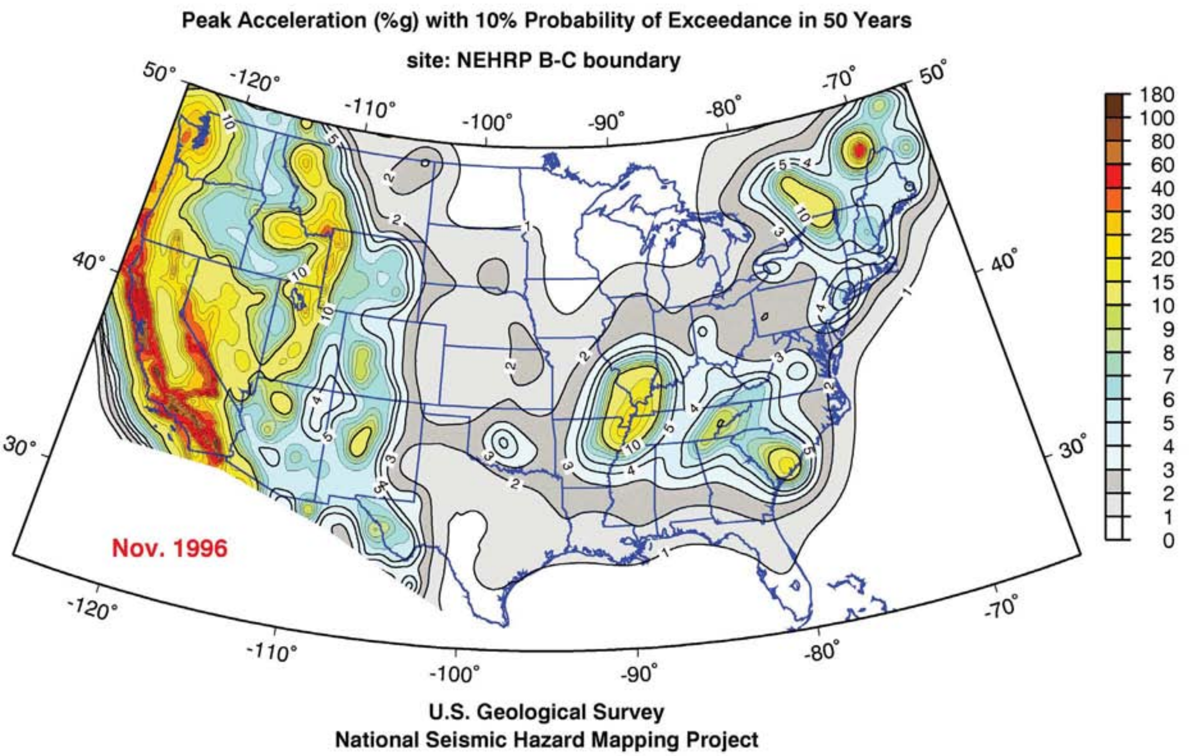


Source: The *International Residential Code*, copyright © 2009, with the permission of the publisher, the International Code Council. The 2009 *International Residential Code* is a copyrighted work of the International Code Council.

Basic wind speeds for 50-year mean recurrence interval

Source: The *International Residential Code*, copyright © 2009, with the permission of the publisher, the International Code Council. The 2009 *International Residential Code* is a copyrighted work of the International Code Council.

Ground snow loads for the United Stations (lb/ft^2)



Source: U.S. Geological Survey, National Seismic Hazard Mapping Project

Seismic Map of Continental U.S.

given resistance capabilities. (Table 2306.3 in the *2009 International Building Code (IBC)* shows these values.)

If there are many shear walls in a building, the engineer usually creates a schedule from a code table to show the wall requirements. Unfortunately, there is no standard for labeling shear walls, so the schedules made by the engineers may all be different. They do, however, usually have common components. You will need to study the shear wall schedule on the plans to understand all the components that apply to framing.

Refer to the Shear Wall Schedule table later in this chapter for an example. It is an easy one to use because the labels also identify the nailing pattern and the type of sheathing. It was developed by the framing council in the state of Washington.

Important Points for Shear Wall Framing

1. **Stud sizes**—Specified nailing patterns may require changes in the stud sizes. There are three conditions where 3x studs are required for nailing adjoining sheathing edges. A fourth condition is required in seismic design category D, E, or F.
   - If the edge nailing is 2½" O.C. or less.
   - If there is sheathing on both sides of the wall, the adjoining sheathing edges fall on the same stud on both sides of the wall, and the nailing pattern is less than 6" O.C.
   - If 10d (3" x 0.148") nails are used with more than 1½" penetration, and they are spaced 3" or less O.C.
   - (For seismic design categories D, E, or F) where shear design values exceed 350 pounds per linear foot.
2. **Penetration**—It is very important that the nail does not penetrate the outside veneer of the sheathing (see "Nail Penetration" illustration.) A pressure regulator or nail-depth gage can be used to make sure this doesn't happen. (See "Nail Regulator and Flush Nailer" illustration.) The top of the nail should be flush with the surface of the sheathing.
3. **Nail size**—The nail size may change from wall to wall. Check the specified thickness and length of the nails.

Framer-Friendly Tips

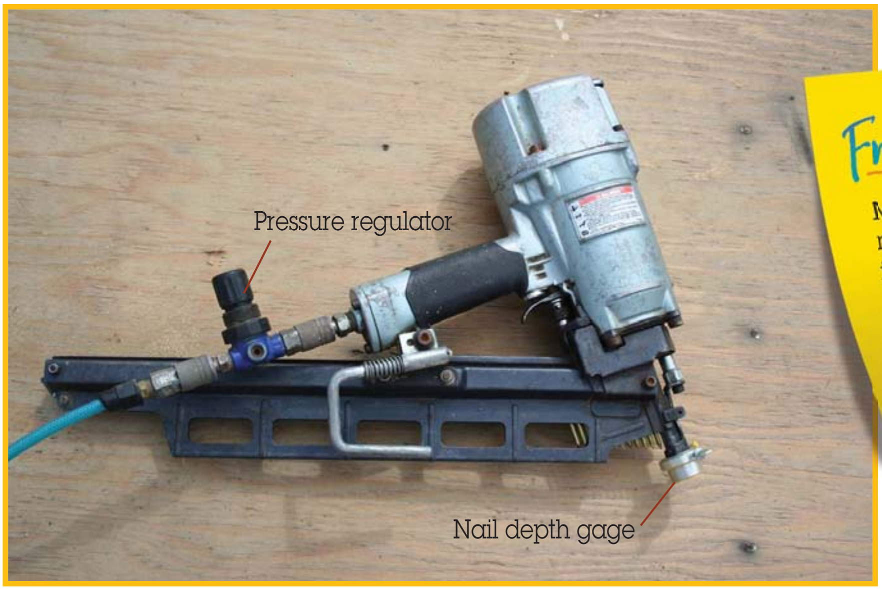
3x studs are used in shear walls at adjoining edges where the nail spacings are small. Check the shear wall schedule.

4. **Nail spacing**—The pattern for nailing the sheathing to the intermediate framing members is usually the standard 12" on center. It is the edge nailing that changes to increase the strength. If 3× studs are required, then the pattern must be staggered. Make sure that the nails are at least 3/8" away from the edge of the sheathing.
5. **Blocking**—The details or shear wall schedule should specify whether blocking is required for panel edges. If the wall is 8' or less, you can usually satisfy this requirement by running the plywood vertically, so that all the panel edges have backing.

Diaphragm Construction

The strength of diaphragms is affected by these factors:

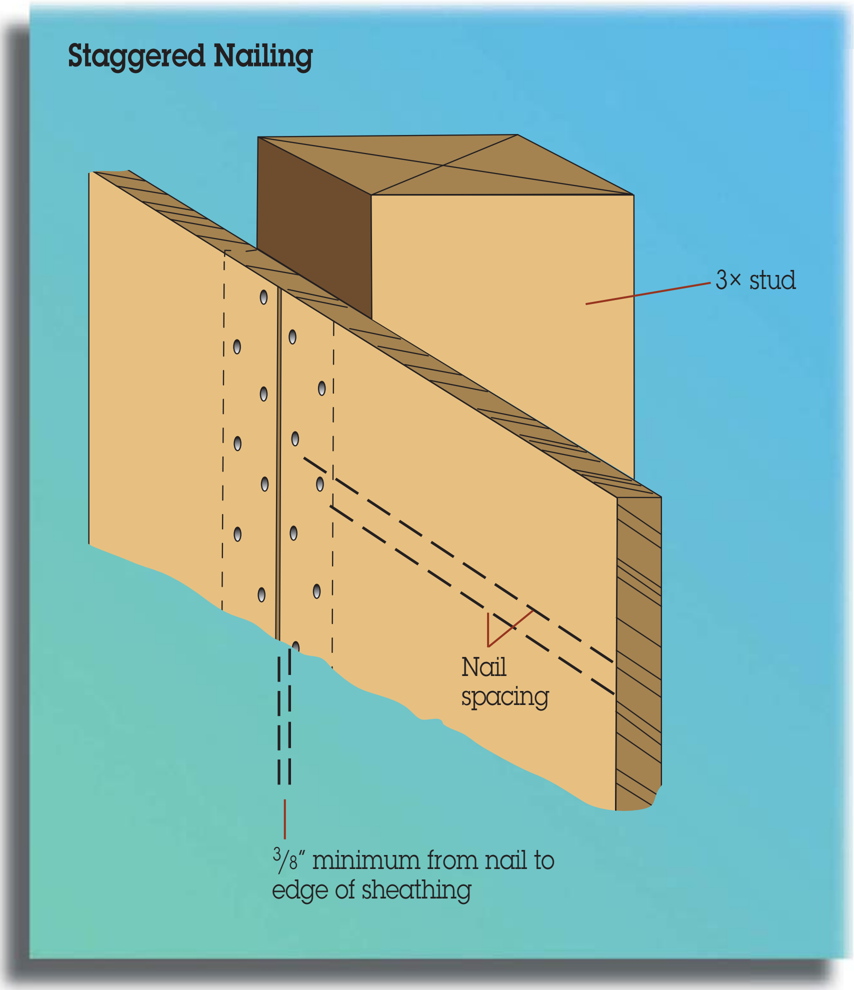
- The size and type of material used for the joists or rafters
- The size and type of material used for the sheathing
- The direction of the sheathing in relation to the members it is attached to
- The nail sizes and patterns
- Any blocks, bridging, or stiffeners



Nail regulator and flush nailer shown affixed to a pneumatic nailer

Framer-Friendly Tips

Many nail guns have flush nailer adjustments built into the gun.

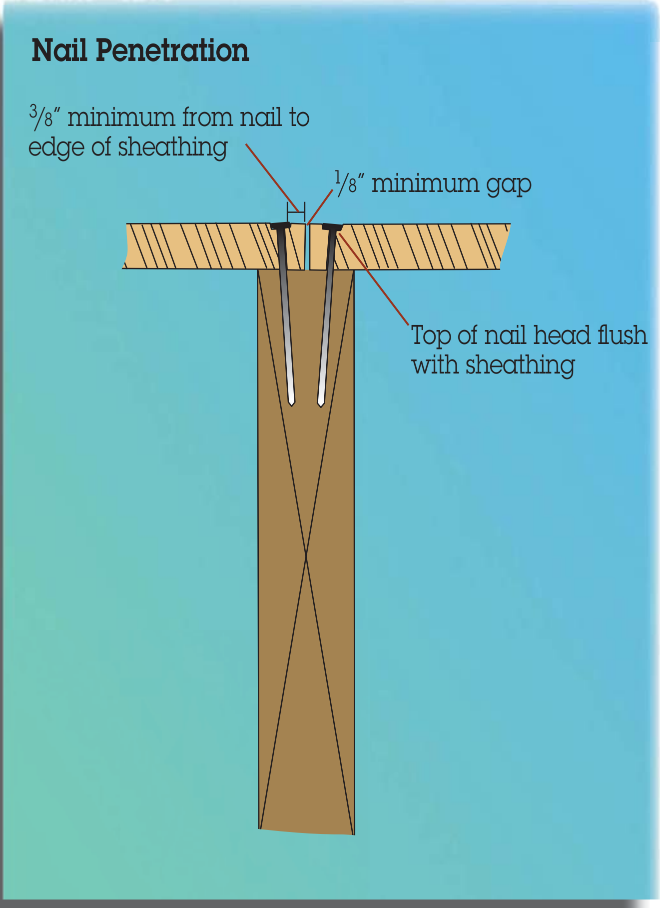


Nailing pattern for shear walls utilizing 3× studs

Building codes provide tables for diaphragms similar to those for shear walls. To summarize, the variables used to increase the strength of the diaphragm are the thickness of the sheathing, the size of the nails, the width of the framing member, the nail spacing, and whether or not the diaphragm is blocked.

Diaphragm Framing Tasks of Particular Concern:

- **Nail spacing**—The nailing pattern for nailing the sheathing to the intermediate framing members is usually the standard 12" O.C. It is the edge nailing that changes to increase the strength.
- **Penetration**—The nail must not penetrate the sheathing's outside veneer.



- **Nail size**—The nail sizes will vary based on the engineer's design, or code requirements. Check the specified thickness and length.
- **Blocking**—It is common to have blocking in the joist space that runs parallel to the exterior walls. It will be detailed on the plans if it is required. Blocking can also be used on the edges of the sheathing.

Connections

"Connectors" can refer to beams or other construction elements, but in most cases, connectors are hardware specifically designed for common framing connections. As part of the load path, connections have to be strong enough to transfer the forces of nature.

In the prescriptive code, the connections are made with anchor bolts to the foundation, and with nails to connect floor joists to the plates below them, wall bottom plates to floors, and rafters or trusses to wall plates.

In non-prescriptive design, there are many ways to achieve the required force transfer between the shear walls, diaphragms, and foundation. The most common method involves metal connectors, which are produced by many companies. The Simpson Strong-Tie Company, because of its work in developing, testing, and cataloging connectors, is often referenced in building plans. Simpson Strong-Tie connector catalog numbers will be used in the balance of this book. Please note that substitutes with equivalent strength are available.

Shear Wall Schedule

Label	APA Rated Sheathing [1][2][4][12][13]	Nail Size & Spacing @ Edges [4][5]	Stud & Blocking Size @ Adjoining Edges [3][6][14]	Rim Joist or Block Connection to Top Plate [7][8]	2 X Bottom Plate Attachment	Sill Plate Attachment		PLF Capacity
					Nailing To Wood Below [9]	Anchor Bolt to Concrete Below [10][15]	Sill Plate Size @ Foundation [11]	
W6	15/32" one side	0.131x2-1/2 @ 6" O.C.	2×	Clip @ 24" O.C.	.148x3-1/4" @ 6"O.C.	5/8"@ 48" O.C.	2×	
W4								
W3								
W2								
2W4 [2]								
2W3 [2]	15/32" two sides	0.131x2-1/2 @ 3"O.C.	3×	Clip @ 12" O.C. EACH SIDE	Clip @ 12" O.C. EACH SIDE [7],[8]	5/8" @ 16" O.C.	3×	
2W2 [2]								
Required Notes								
[1] Install panels either horizontally or vertically								
[2] Where sheathing is applied on both sides of wall, panel edge joints on 2x framing shall be staggered so that joints on the opposite sides are not located on the same studs.								
[3] Blocking is required at all panel edges.								
[4] Provide shear wall sheathing and nailing for the entire length of the walls indicated on the plans. Ends of full height walls are designated by exterior of the building, corridors, windows, or doorways, or as designated on plans. See plans for holdown requirements. (Alternate note: walls designated as perforated shear walls require sheathing above and below all openings.)								
[5] Sheathing edge nailing is required at all holdown-posts. Edge nailing may also be required to each stud used in built-up holdown posts. Refer to the holdown details for additional information.								
[6] Intermediate framing to be with 2x minimum members. Field nailing 12" O.C.								
[7] Based on 0.131 x 1-1/2" long nails used to attach framing clips directly to framing. Use 0.131 x 2-1/2" nails where installed over sheathing								
[8] Framing clips: A35 or LTP5 or approved equivalent								
[9] Where plate attachment specifies (2) rows of nails, provide double joist, rim or equal. Attach per details.								
[10] (In Seismic Design Categories D,E&F) Anchor bolts shall be provided with steel plate washers 3/16"x2"x2". Embed anchor bolts 7" minimum into the concrete.								
[11] Pressure-treated material can cause excessive corrosion in the fasteners. Provide hot-dipped galvanized (electro-plating is not acceptable) nails and connector plates (framing angles, etc.) for all connectors in contact with pressure treated framing members.								
Alternate Notes								
[12] 7/16" APA rated sheathing (OSB) may be used in place of 15/32" sheathing provided that all studs are spaced at 16" O.C.								
[13] Where wood sheathing (W) is applied over gypsum sheathing (G), contact the engineer of record for alternate nailing requirements.								
[14] At adjoining panel edges, (2) 2x studs nailed together may be used in place of a single 3x stud. Double 2x studs may be connected together by nailing the studs together with 3" long nails of the same spacing and diameter as the plate nailing.								
[15] Contact the engineer of record for adhesive or expansion bolt alternatives to cast-in-place anchor bolts. (Special inspection may be required.)								

There are connectors made for just about every type of connection you can think of. As the framer in charge, however, it is not your job to decide on the type of connector, but rather to use correctly the connector that is specified. The best way to do this is to read the specifications in the connector catalog. Following is an illustration from a Simpson Strong-Tie Catalog, and a good example of instructions for installing hold-downs. You can reference the connectors at www. strongtie.com.

There are different connectors for the variety of different framing details, but only four common areas of connection:

- Foundation
- Wall-to-wall
- Roof-to-wall
- Foundation-to-top-of-the-top-wall

Important Points for Connection Framing

- Install all connectors per catalog instructions.
- Drill holes no more than 1/16" bigger than bolts.
- Use washers next to wood.
- Fill all nail holes unless using catalog specifications.
- Know that the connection is only as strong as the weakest side. Make sure to space and nail each side the same. (See "Equal Nailing" illustration later in this chapter.)
- Be aware that some connectors have different-shaped nail holes. The different-shaped holes have different meaning, as illustrated in "Nail Hole Shapes" later in this chapter.

Hold-Downs

Hold-downs are connections commonly used for foundations, wall-to-wall connections, wall-to-concrete connections, and wall or floor-to-drag strut. Hold-downs are also called *anchor downs* and *tie-downs*. They can be difficult to install, but if you plan ahead and install as you go, the job is more manageable. Hold-downs that attach walls to the concrete foundation are typically attached to bolts already in the concrete. These bolts are generally set in place by the foundation crew. Sometimes they won't be set in the right place.

You will want to locate the hold-down as close to the end of the shear wall as possible. If the bolt is already in the concrete, you will have to locate a hold-down on either side of the bolt. When considering the location, be aware of how it relates to what is on the floor above it; you don't want, for example, the hold-down coming up in a door or window. You should also allow enough space to install and tighten nuts and bolts.

When to Install Hold-Downs

Although it is common to wait until the building is framed to install the hold-downs, waiting can also present problems, such as studs that are already nailed in place where you want to install the hold-downs, sheathing that is hard to nail because it may be on the exterior of a second or higher floor, and possible pipes or wires running in the stud cavity.

It is helpful to install the hold-down studs as you build the walls. The layout framer should detail the hold-down studs while detailing the wall plates, and should also drill the plates for the anchor bolt or the threaded rods. If an upper floor is involved, the framer should also drill down through the subfloor sheathing and the top and double plate of the wall on the floor below. The wall builder should drill the

HDQ8/HHDQ *Holdowns*

The HHDQ series of holdowns combines low deflection and high loads with ease of installation. The unique seat design of the HDQ8 greatly minimizes deflection under load. Both styles of holdown employ the Simpson Strong-Tie® Strong-Drive® SDS screws which install easily, reduce fastener slip and provide a greater net section area of the post when compared to bolts. They may be installed either flush or raised off the mudsill without a reduction in load value.

SPECIAL FEATURES:

- Uses SDS screws which install easily, reduce fastener slip, and provide a greater net section area of the post compared to bolts.
- SDS screws are supplied with the holdowns to ensure proper fasteners are used.
- No stud bolts to countersink at openings.

MATERIAL: HDQ8—7 gauge; HHDQ—Body: 7 gauge, washer: ½" plate

FINISH: HDQ8—Galvanized; HHDQ— Simpson Strong-Tie® gray paint

INSTALLATION: • Use all specified fasteners. See General Notes.

- For use in vertical and horizontal applications.
- No additional washer is required.
- To tie multiple 2x members together, the Designer must determine the fasteners required to join members without splitting the wood.
- See SB and SSTB Anchor Bolts on pages 36-40 for anchorage options.
- SDS screws install best with a low speed high torque drill with a ⅜" hex head driver.

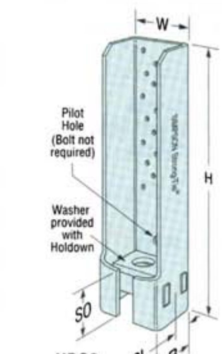
HDQ8:

- ⅝" of adjustability perpendicular to the wall.
- See SSTB Anchor Bolts, page 38-40, for anchorage options. For 2-2x and 3x sill plates use SSTBL models. The Designer may specify any alternate anchorage calculated to resist the tension load for a specific job. Anchorage length should take the bearing plate/washer height into account, to ensure adequate length of threads to engage the nut.

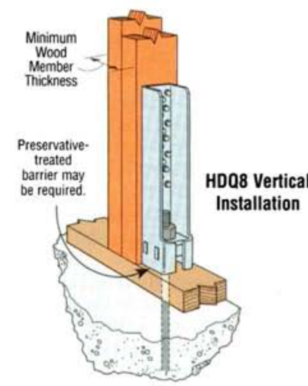
HHDQ11/14:

- No additional washer is required.
- HHDQ14 requires a heavy hex anchor nut *(supplied with holdown)*
- See SB and SSTB Anchor Bolts, pages 36-40, for anchorage options.

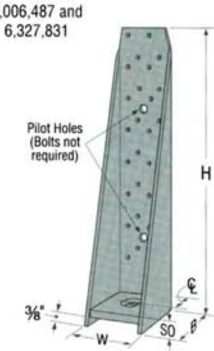
CODES: See page 20 for Code Reference Key Chart.



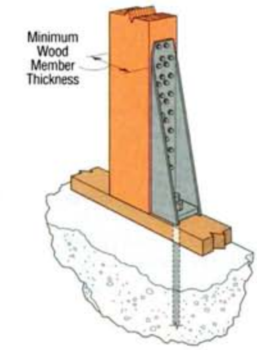
HDQ8
U.S. Patents 6,006,487 and 6,327,831



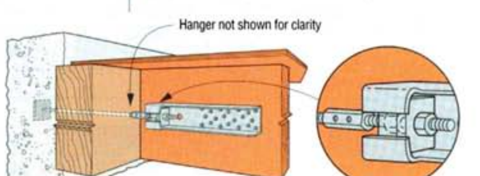
HDQ8 Vertical Installation



HHDQ11
(HHDQ14 similar)



Vertical HHDQ11 Installation
(HHDQ14 similar)



Horizontal HDQ8 Installation

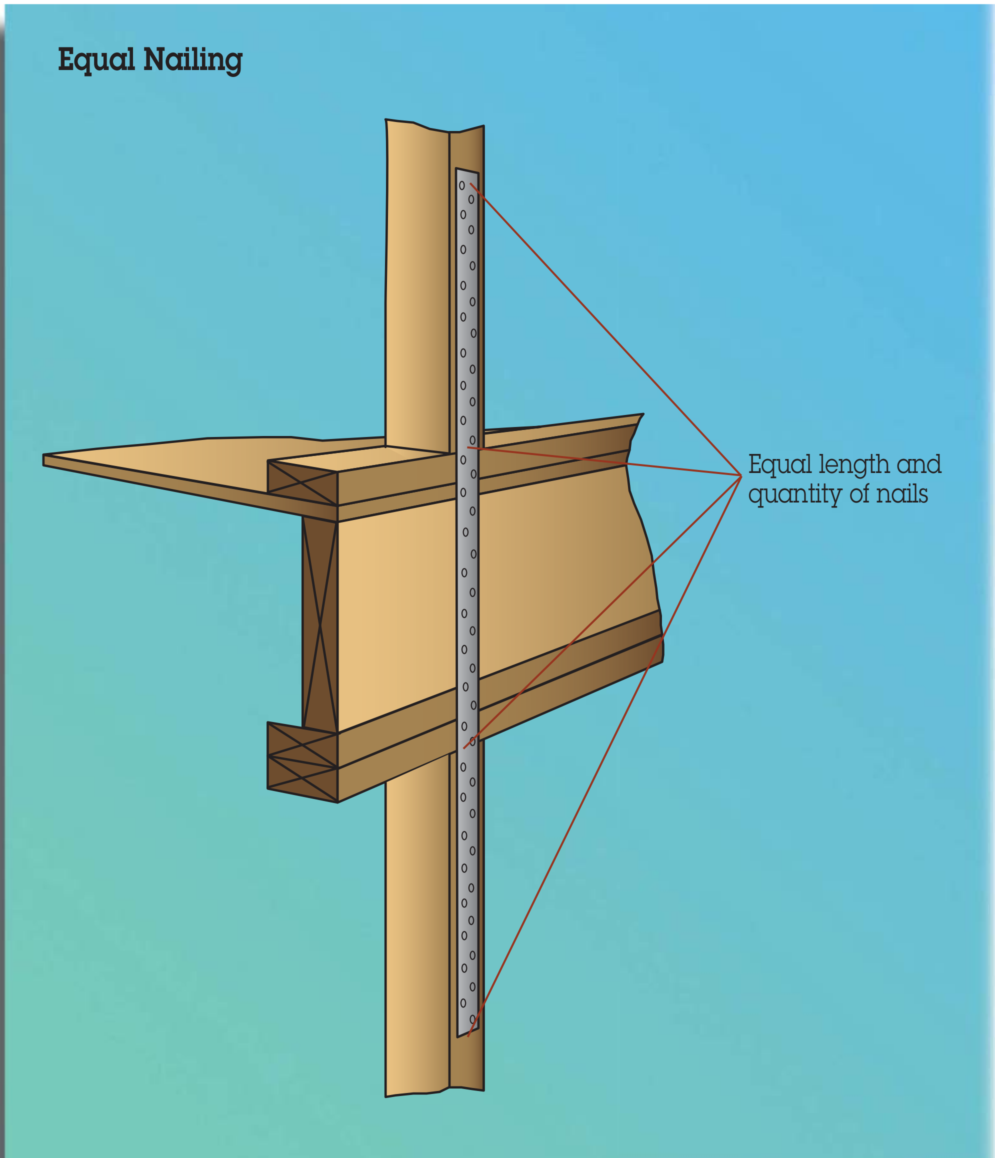
For holdowns, per ASTM test standards, anchor bolt nut should be finger-tight plus ⅓ to ½ turn with a hand wrench, with consideration given to possible future wood shrinkage. Care should be taken to not over-torque the nut. Impact wrenches should not be used.

These products are available with additional corrosion protection. Additional products on this page may also be available with this option, check with Simpson Strong-Tie for details.

Model No.	Ga	Dimensions (in.)					Fasteners		Minimum Wood Member Thickness[4] (in.)	Allowable Tension Loads (lbs.) (160)			Code Ref.
		W	H	B	℄	SO	Anchor Bolt Dia. (in.)	SDS Screws		DF/SP	SPF/HF	Deflection at Allowable Load[6] (in.)	
HDQ8-SDS3	7	2⅞	14	2½	1¼	2⅜	⅞	20-SDS ¼"x3"	3	5715	4115	0.064	I6, L8, F5
								20-SDS ¼"x3"	3½	7630	5495	0.094	
								20-SDS ¼"x3"	4½	9230	6645	0.095	
HHDQ11-SDS2.5	7	3	15⅛	3½	1½	⅞	1	24-SDS ¼"x2½"	5½	11810	8505	0.131	
HHDQ14-SDS2.5	7	3	18¾	3½	1½	⅞	1	30-SDS ¼"x2½"	7¼	13015[9]	9370[9]	0.107	
									5½[8]	13710[8,9]	10745[9]	0.107	

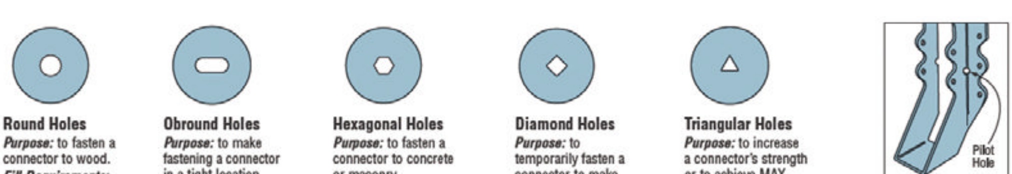
1. Allowable loads have been increased for earthquake or wind load durations with no further increase allowed; reduce where other load durations govern.
2. The Designer must specify anchor bolt type, length and embedment. See SB and SSTB Anchor Bolts *(pages 36-40)*.
3. Structural composite lumber columns have sides that show either the wide face or the edges of the lumber strands/veneers. Values in the tables reflect installation into the wide face. See technical bulletin T-SCLCOLUMN for values on the narrow face (edge) *(see page 215 for details)*.
4. Post design by Specifier. Tabulated loads are based on a minimum 3½" wide post (in a 3½" wall). Post may consist of multiple members provided they are connected independently of the holdown fasteners. See pages 210-211 for common post allowable loads.
5. Tension values are valid for holdowns flush or raised off of sill plate.
6. Deflection at Allowable Tension Load includes fastener slip, holdown deformation and anchor rod elongation for holdowns installed up to 6" above top of concrete. Holdowns may be installed raised up to 18" above top of concrete with no load reduction provided that additional elongation of the anchor rod is accounted for.
7. Tabulated loads may be doubled when holdowns are installed on opposite sides of the wood member provided either the post is large enough to prevent opposing holdown screw interference or the holdowns are offset to eliminate screw interferences.
8. Noted HHDQ14 allowable loads are based on a 5½" wide post *(6x6 min.)*. All other loads are based on 3½" wide post minimum.
9. Requires heavy hex anchor nut to achieve tabulated loads *(supplied with holdown)*.
10. HDQ and HHDQ holdowns installed horizontally can achieve compression loads with the addition of a standard nut on the underside of the load transfer plate. Refer to ESR 2330 for design values. Design of anchorage rods for the compression force shall be per the Designer.

Equal Nailing



Just as a chain is only as strong as its weakest link, this strap and its ability to hold two walls together is only as good as its weakest side.

Nail Hole Shapes



Round Holes
Purpose: to fasten a connector to wood.
Fill Requirements: always fill, unless noted otherwise.

Obround Holes
Purpose: to make fastening a connector in a tight location easier.
Fill Requirements: always fill.

Hexagonal Holes
Purpose: to fasten a connector to concrete or masonry.
Fill Requirements: always fill when fastening a connector to concrete or masonry.

Diamond Holes
Purpose: to temporarily fasten a connector to make installing it easier.
Fill Requirements: none.

Triangular Holes
Purpose: to increase a connector's strength or to achieve MAX strength.
Fill Requirements: when the Designer specifies max nailing.

Pilot Holes
Tooling holes for manufacturing purposes. No fasteners required.

Source: Simpson Strong-Tie Company, Inc.

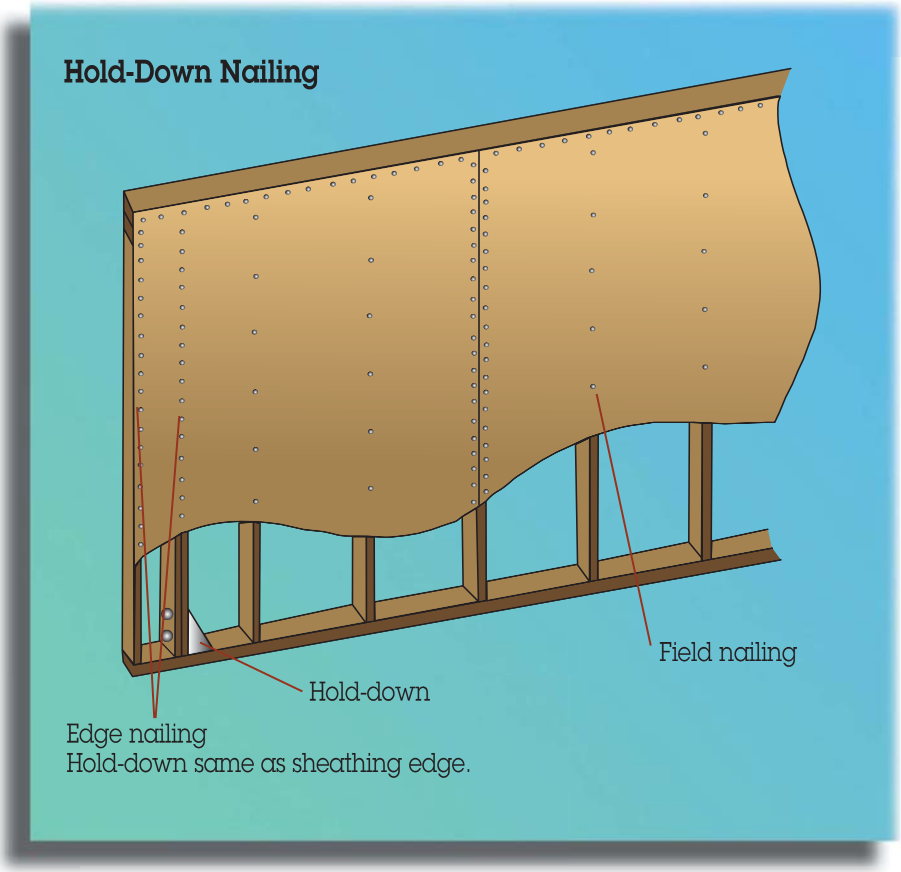
studs before nailing them into the wall. When the wall sheathing is installed, make sure it is nailed to the hold-down studs using the same nailing pattern that was used for edge nailing. (See "Hold-Down Nailing" illustration.)

Install the hold-downs and bolts, and washers and nuts, as soon as possible. Note, too, that when installing hold-downs after the walls are built, it is more productive to do an entire floor at one time. If the anchor bolts in the concrete do not extend high enough, a coupler nut can be used to extend the length. (See "Coupler Nuts Can Extend Anchor Bolts" illustration.)

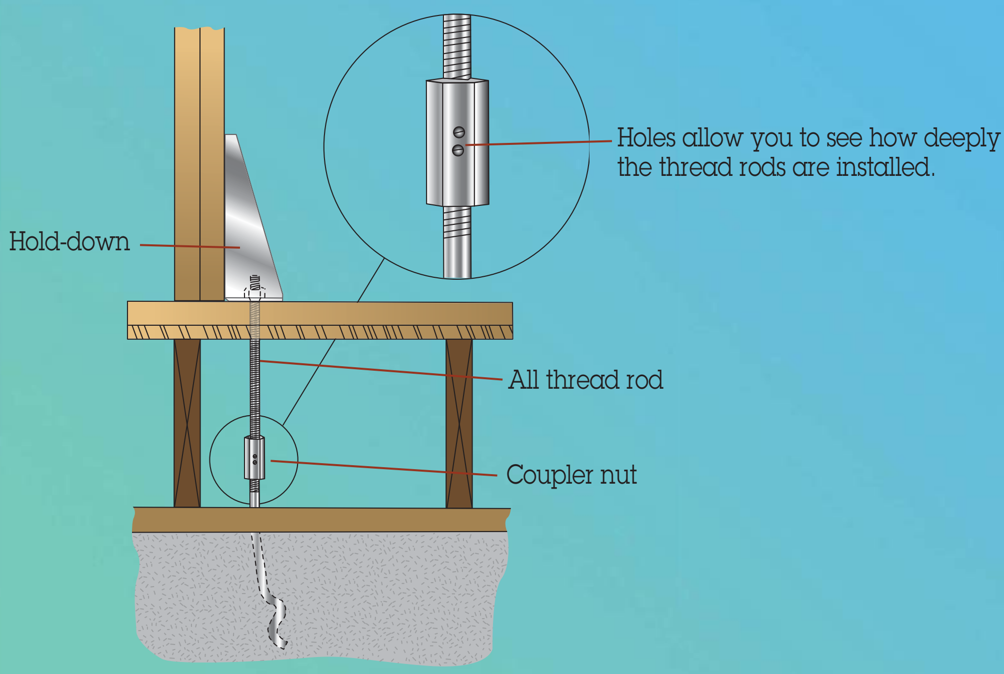
As noted previously, the holes drilled for the bolts attaching the hold-down to the studs should not be more than 1/16" bigger than the bolts. However, it is acceptable to oversize the holes you drill for the threaded rod that passes between the floors. This will make installation easier without affecting strength. (See "Drill Hole Size for Hold-Downs" illustration.)

With all nail-on connection hardware, it is important to use the right size nail. Hardware manufacturer's catalogs indicate nail size appropriate for each piece of hardware. Most catalogs also give some options for nail use.

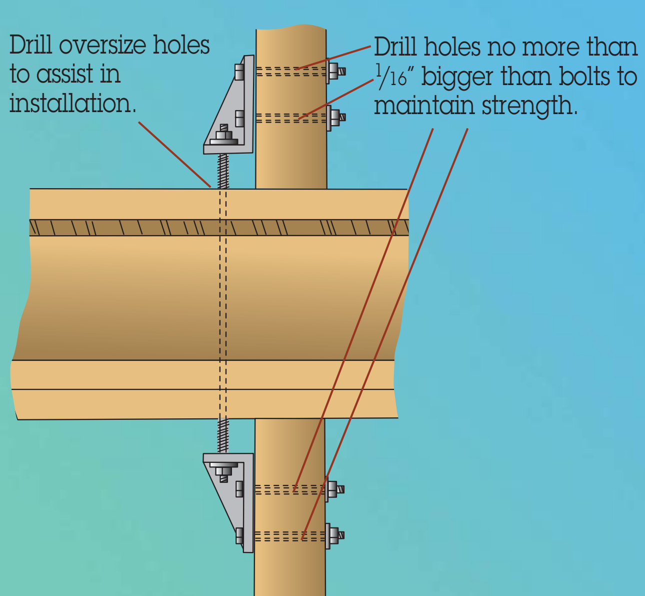
Hold-downs



Coupler Nuts Can Extend Anchor Bolts



Drill Hole Size for Hold-Downs



Positive Placement Nail Guns

Earthquakes, hurricanes, and tornados continue to wreak havoc on our wood frame houses and buildings. We will never be able to completely protect against the worst case scenario, however our codes are continually improving so that we can make our buildings stronger. A big part of this improvement has been the addition of connection hardware. Whereas most connections used to be secured by nails, connections needed to establish shear and diaphragm strength are now secured by hardware. Most of this hardware is fastened with nails and in many cases a large number of nails. For example, where a small framing clip may take 12 nails, a four foot strap may take 32 nails, depending on the particular size and type of connector.

Because of all the additional hardware nailing, nail gun manufacturers have come out with positive placement nail guns that are specially made for nailing on hardware. There are different styles but they all use the same nails which are different from standard nail guns. The nails are hardened and come in four sizes which are .131 × 1-1/2", .148 × 1-1/2", .148 × 2-1/2", and .162 × 2-1/2". The guns use two methods to find the nail holes in the hardware. One style uses a probe that is placed in the hole, and then the gun directs the nail. In the other style, the nail protrudes so that the nail is placed in the hardware hole before firing the gun.

You need to make sure you use the right nail for the hardware. Each piece of hardware has its own nail requirements. If you use too big a nail you can fracture the steel around the nail hole, and if you use too small a nail you will not develop the appropriate strength needed. Hardware manufacturer specifications note the requirements. For example on the web at strongtie.com, Simpson Strong-Tie Company lists all their hardware with the amount and size of nails needed. There is also a convenient nail replacement chart which lists some nail size substitutions. This is helpful when you are installing hardware that was designed for standard nails but you are using positive placement gun nails. You can find this chart at strongtie.com/products/connectors/nails.asp.

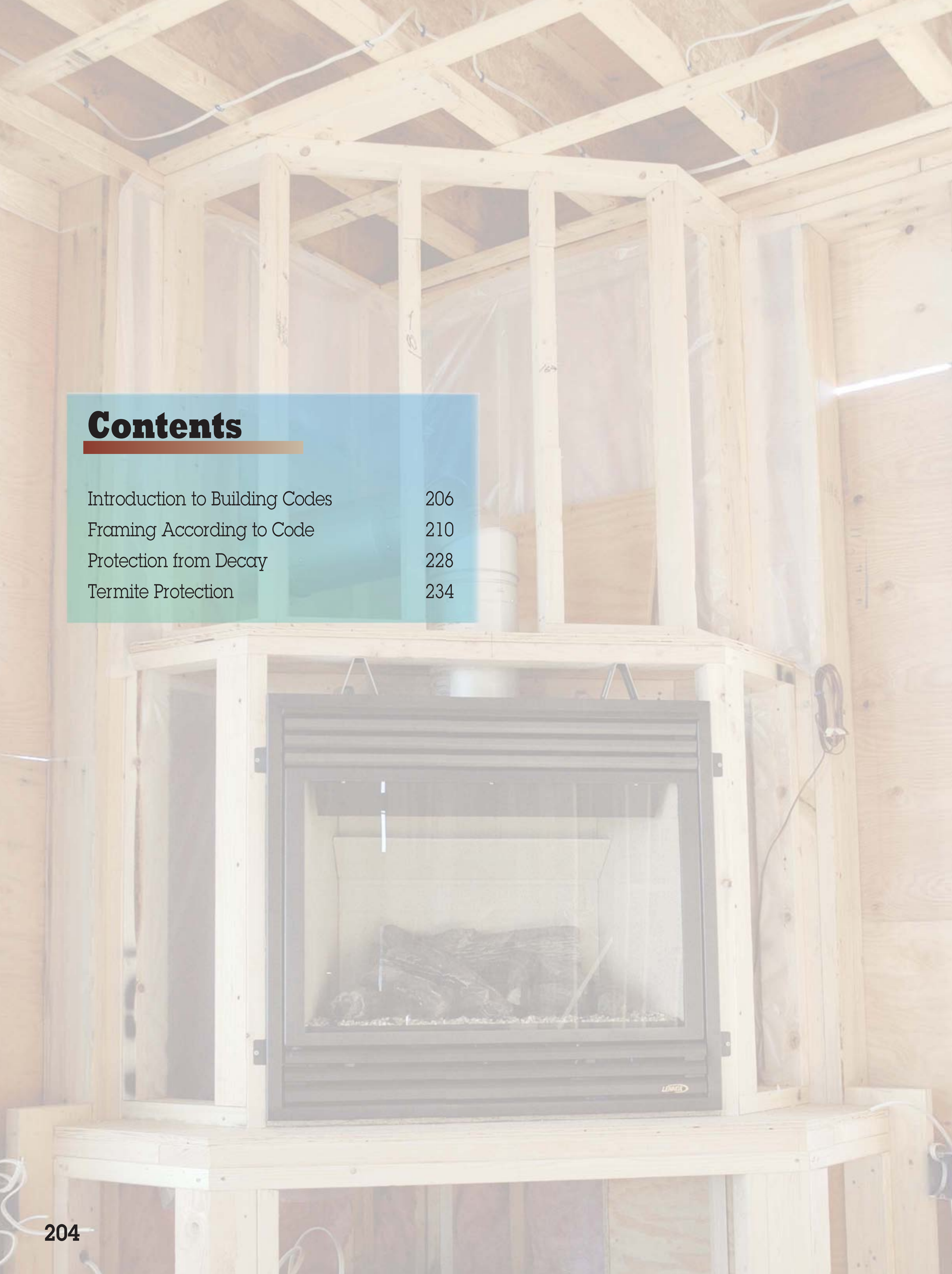
Conclusion

Quality of installation is probably the most important part of framing to withstand the forces of nature. APA (formerly the American Plywood Association, now the Engineered Wood Association) confirmed this fact when it conducted a study of the construction failures in the aftermath of Hurricane Andrew. In the houses they investigated, roofs were the most common failures. Those roof systems most often failed due to lack of proper sheathing nailing.

Wind- and earthquake-resistant framing are important skills for lead framers, and essential to those in susceptible parts of the country. Building codes, along with the designs architects and engineers create to meet code requirements, specify the framing for wind and earthquake resistance. The lead framer must take that information, along with data from connector manufacturers, and ensure that those requirements are met.

Roof failure as a result of Hurricane Andrew

Chapter Ten
BUILDING CODE REQUIREMENTS



Contents

Introduction to Building Codes 206

Framing According to Code 210

Protection from Decay 228

Termite Protection 234

Chapter Ten

BUILDING CODE REQUIREMENTS

Framers, builders, architects, engineers, and building inspectors alike have contributed to the system of building codes we use today. You should be aware of the codes that apply to the part of the country you are working in, as well as the important features of those codes. This chapter will discuss what you should know about building code requirements.

Introduction to Building Codes

The Evolution of Building Codes

Although carpentry is one of the oldest professions, framing as we know it today didn't start until 1832 when a man named George Snow wanted to build a warehouse in Chicago. It was difficult to obtain enough large timbers to build the structure using the traditional post and beam method. Being creative (as all good builders and lead framers must be), he cut up the small timbers he had growing on his property into pieces similar to 2 × 4s. He placed them in a repetitive manner, thus creating the first 2 × 4 style walls.

Since then, architects, engineers, builders, building inspectors, and framers have all contributed to the system we use today. Along the way, builders constructed buildings in the way they saw fit. Although this "every man for himself" approach to building gave us structures to live and work in, it did not guarantee that such buildings would last a lifetime, be safe to live and work in, or stand up against earthquakes and hurricanes.

It wasn't until 1915 that a group of building officials decided they needed a standard. That year, the Building Officials & Code Administrators International (BOCA) was established to bring some uniformity to the systems being used.

The IBC

Two other building code agencies appeared not long after: the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI). All three organizations worked to meet the particular needs of their regions of the country.

In the year 2000, these agencies combined their codes to create one common code that would cover the entire country. This code is divided into two books: the *International Residential Code* (IRC), which covers all one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories in height, and the *International Building Code* (IBC), which covers all buildings. Separating the code in this way makes it easier to find the information you need. If you are building only houses, duplexes, or townhouses, you would go straight to the IRC.

There are two ways to comply with the code. The *prescriptive method*, most commonly used, gives specific requirements (such as how many inches on center to space the framing lumber) to build walls that are acceptable. The *performance method* tells us how a person can determine the strength of a wall using properly stamped, graded lumber, and if that strength meets the minimum code requirements.

Because the prescriptive system is most commonly used, it is the one we'll cover here. It applies to conventional construction otherwise known as *platform* or *balloon* framing, which has been developed over the years on job sites, and has been tested and standardized. Prescriptive code requires no "engineering" design by a registered professional, as long as the project is built in compliance with the *International Residential Code* (IRC) or *International Building Code* (IBC).

(Note that with a performance-rated system, you will have a set of plans that you must follow to the letter. These plans come with structural components that must be used exclusively with the plans. Performance-rated codes require design by a registered professional who must specify in accordance with the IRC or IBC.)

A Framer's Code Responsibility

Although it may seem that the codes are written for lawyers instead of framers, framers must be sure that their work complies to code. Note that some areas of the country may not be covered by

a statewide, town, city, or county code. (Counties have historically been the jurisdictions controlling code establishment and enforcement.) Note, too, that code-writing organizations are not government agencies, so codes are not enforceable until or unless a government jurisdiction accepts the codes and makes them part of local law.

Code Revisions & Time Delays

Code Revisions

Revisions are important to keep in mind when working with codes. Codes are normally updated annually, and revised versions are published every three years. Typically, the revisions are not major, but it is important to know which code you must comply with. On some jobs the plans will indicate which codes apply. This information can usually be found on the cover page or with the general specifications in the plans. If the applicable code is not shown on the plans, ask the builder, owner, or whoever acquired the building permit about the code.

Time Delays

Another thing to keep in mind is the time that may elapse between when the code-writing organizations publish a revised code and when that code edition becomes the ruling code on the job you are framing. There are delays between when the code agencies certify the new codes and when the local government agencies review and approve them. There can also be delays between the date the permit is issued and the date the job is framed. It is not unusual to be working on plans that are three or four years or more behind the current building code. Although you have to comply with the code that is specified on the plans or that was used when the building permit was approved, you should also understand the current code because, in general, additions to the codes are improvements, or ways that contribute to making a building stronger. After every major earthquake or hurricane, codes have been adjusted and upgraded. By using the latest code, you can feel confident that you are framing with the latest construction knowledge.

Latest Code Used in This Book

This book uses the 2009 edition of the IBC and IRC to explain the major features of codes related to framing. These include structural requirements and life safety issues, and the spreading of fire. Although the code books may seem big and intimidating when you first see them, the number of pages that deal with framing are relatively few.

The following IBC & IRC Framing Index table is a handy list of all the framing sections of either code you might need. It was compiled based on the 2009 code books. In the IRC, the framing information can be found primarily in 4 of the total 43 chapters. In the IBC, 3 of the total 35 chapters deal with framing. The IRC framing chapters are 3, 5, 6, and 8. The IBC chapters containing framing information are 10, 12, and 23.

Important Code Features

What follows are key features of the code, and illustrations presented in a framer-friendly way. If you do a lot of framing, it's a good idea to have a copy of the code book available for reference.

The three major categories used in the IBC are:

- Use and occupancy classification
- Fire-resistance-rated construction classification
- Seismic design categories

In the IBC, the seismic design categories are based on their seismic use group. The categories are A, B, C, D, D[a], E, and F. Although they are similar to the categories in the IRC, there are some differences.

IBC IRC Framing Index

Framing code	IRC #	IRC page	IBC #	IBC page	Table-Fig.
Floor Framing					
Double joists under bearing partitions	R502.4	114	2308.8.4	478	
Bearing	R502.6	114	2308.8.1	478	
Girders			2308.7	478	
Minimum lap	R502.6.1	114	2308.8.2	478	
Joist support	R502.6.2	114	2308.8.2	478	
Lateral support	R502.7	114	2308.8.2	478	
Bridging	R502.7.1	114	2308.8.5	483	
Drilling and notching	R502.8	114	2308.8.2	478	
Framing around openings	R502.10	114	2308.8.3	478	
Framing around openings - seismic			2308.11.3.3	513	
Wall Framing					
Stud size, height and spacing	R602.3	146	2308.9.1	483	R602.3.1
					IBC-2308.9.1
Cripple wall stud size	R602.9	157	2308.9.4	489	
Cripple wall connection			2308.11.3.2	513	IBC-2308.11.3.2
Double and top plate overlap	R602.3.2	146	2308.9.2.1	483	
Drilling and notching	R602.6	155	2308.9.10	489	R602.6(1)&(2)
			2308.9.11	489	R602.6.1
Headers	R602.7	157			R502.5(1)&(2)
					R602.7.2
			2308.9.5	489	IBC-2308.9.5&6
Fireblocking	R602.8	157	717.2	121	
Wall bracing	R602.10&11	159-185			R602.10.2-
					R602.11.2
			2308.9.3	484-489	IBC-2308.9.3&(1)
Braced wall lines			2308.3	477	
Anchor bolts	R602.11.1	184	2308.3.3	477	R602.3(2)
			2308.6	478	
Plate washers	R602.11.1	184	2308.12.8	516	
Rafter Framing					
Ridge board and hip & valley rafters	R802.3	374	2308.10.4	493	
Rafter bearing	R802.6	374			
Drilling and notching	R802.7	375	2308.10.4.2	511	
Lateral support	R802.8	375	2308.10.6	511	
Framing around openings	R802.9	375	2308.10.4.3	511	
Roof tiedowns & wind uplift	R802.11	376	2308.10.1	489	
Rafter connections	R802.3.1	374	2308.10.4.1	493	
Ceiling Framing					
Ceiling heights	R305.1	54	1208.1	273	
Ceiling joist lapped	R802.3.2	374			
Ceiling joists bearing	R802.6	374			
Ceiling joist connectors			2308.10.4.1	493	
Ceiling framing			2308.1	489	IBC-2308.10.2(1)&(2)

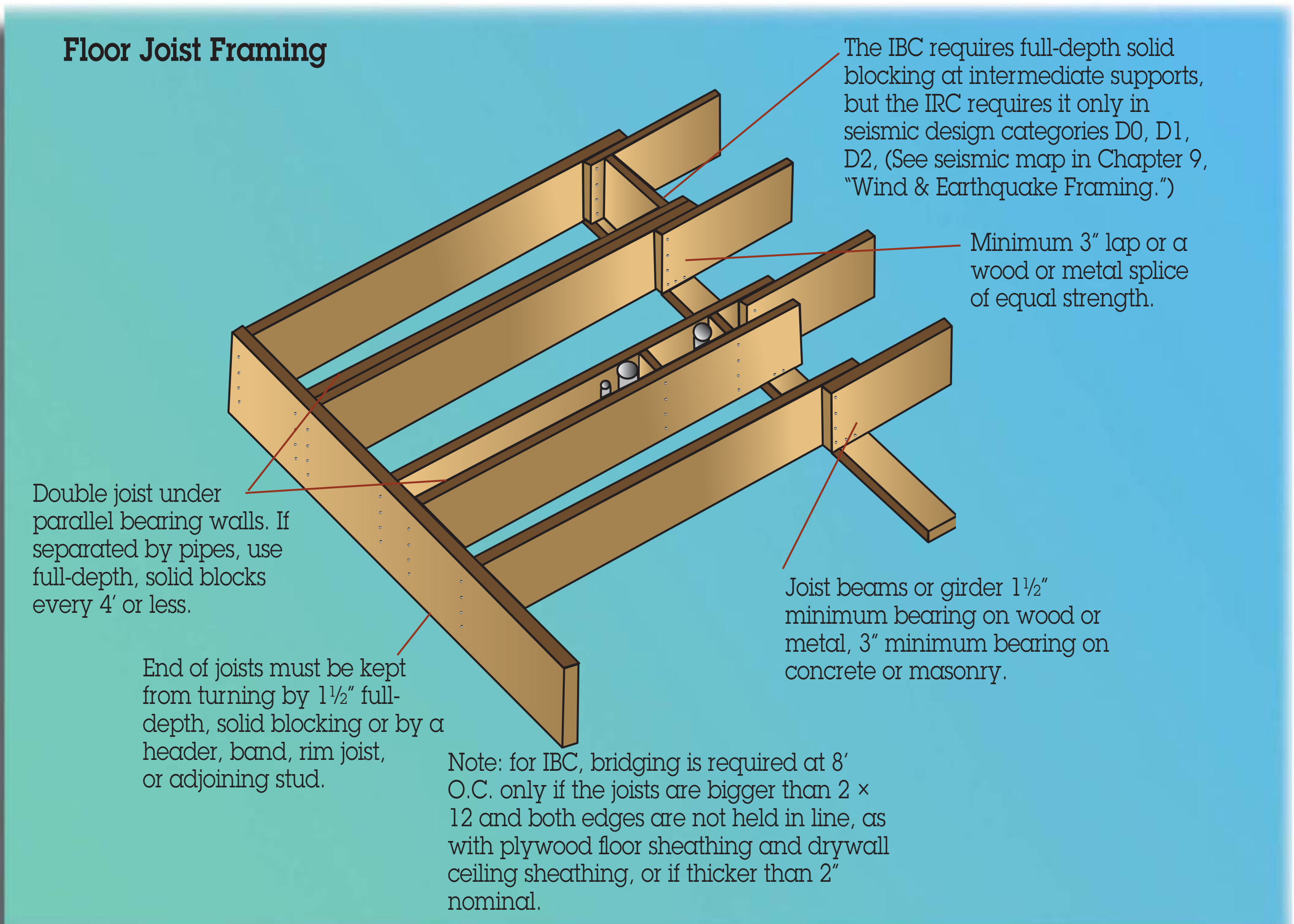
Truss Framing					
Truss bracing	R802.10.3	376	2303.4.1.2	455	
Truss alterations	R802.10.4	376	2303.4.5	455	
Attic Access					
Attic spaces	R807.1	431	1209.2	274	
Attic access	R807.1	431	1209.2	274	
Stair & Ramp Framing					
Stair landings	R311.7.5	60	1009.5	231	
Stair width	R311.7.1	60	1009.1	230	
Stair treads & risers	R311.7.4	60	1009.4	230	
Stair headroom	R311.7.2	60	1009.2	230	
Spiral stairs	R311.7.9.1	61	1009.9	232	
Curved stairs			1009.8	232	
Handrails	R311.7.7	60	1009.12	233	
Ramps	R311.8	61	sect. 1010	233	
Ventilation					
Attic	R806	430-431	1203.2	271	
Under floor	R408	108	1202.3	271	
Roof	R806	430	1503.5	288	
Nailing					
Nailing	R602.3(1)	147	2304.9.1	462	IBC-2304.9.1
Sheathing nailing	R602.3(1)	148	2304.9.2	464	IBC-2304.9.1
Prevention of Decay					
Pressure treated	R317	65	2304.11.1	465	
Pressure treated joists, girders & subfloor			2304.11.2.1	465	
Pressure treated framing			2304.11.2.3	465	
Pressure treated sleepers & sills			2304.11.2.4	465	
Girder ends at masonry			2304.11.2.5	465	
Pressure treated post & columns	R317.1.4	65	2304.11.2.7	465	
			2304.11.4.1	465	
Pressure treated laminated timbers			2304.11.3	465	
Pressure treated wood contact with ground			2304.11.4	465	
Pressure treated wood structural members	R317.1.5	65	2304.11.4.2	466	
			2304.11.5	466	
Termite protection					
termite protection	R318	66	2304.11.6	466	
termite probability map		40			R301.2(6)
Miscellaneous					
Wind limitations	R301.2.1	23			
Seismic limitations	R301.2.2	44			
Minimum fixture clearance bath & shower	R307	55			R307.1
Framing around flues & chimneys			2304.5	456	
SIPs (Structural Insulated Panel) Walls	R613	348-356			
Safety					
Safety			33	567	
Safeguards			33	567	

Framing According to Code

Floor Framing

Following are the code requirements and instructions related to floor framing:

- Double joists are required under parallel bearing walls.
- If pipes penetrate floors where double joists are required, the joists must be separated and have full-depth, solid blocks at least every 4' along their length.
- Bearing for joists must be 1½" minimum on wood or steel, and 3" minimum on concrete or masonry.
- Where joists lap, there must be a minimum lap of 3" or a wood or metal splice of equal strength.
- The ends of joists must be kept from turning by using 1½" full-depth solid blocking or by attaching them to a header, band, rim joist, or adjoining stud.



- Full-depth, solid blocking is required at intermediate supports in IRC seismic design categories D1, D2, and E. (See seismic maps in Chapter 9.)
- Bridging at 8' O.C. is required only when joists are larger than 2 × 12, and both edges are not held in line, as with plywood floor sheathing and drywall sheathing, or if thicker than 2" nominal.

The "Floor Joists—Anchor or Ledger" illustration below shows how joists framing into girders must be supported by framing anchors or a 2 × 2 or larger ledger.

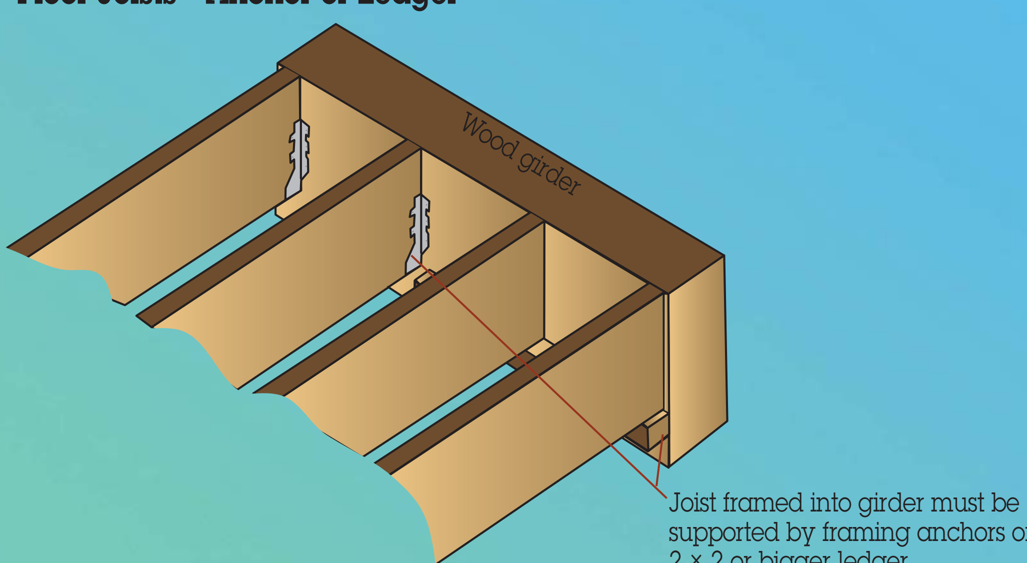
Engineered wood products, such as I-joists, can be notched according to the manufacturer's specifications. (See Chapter 8 for more on engineered wood products.)

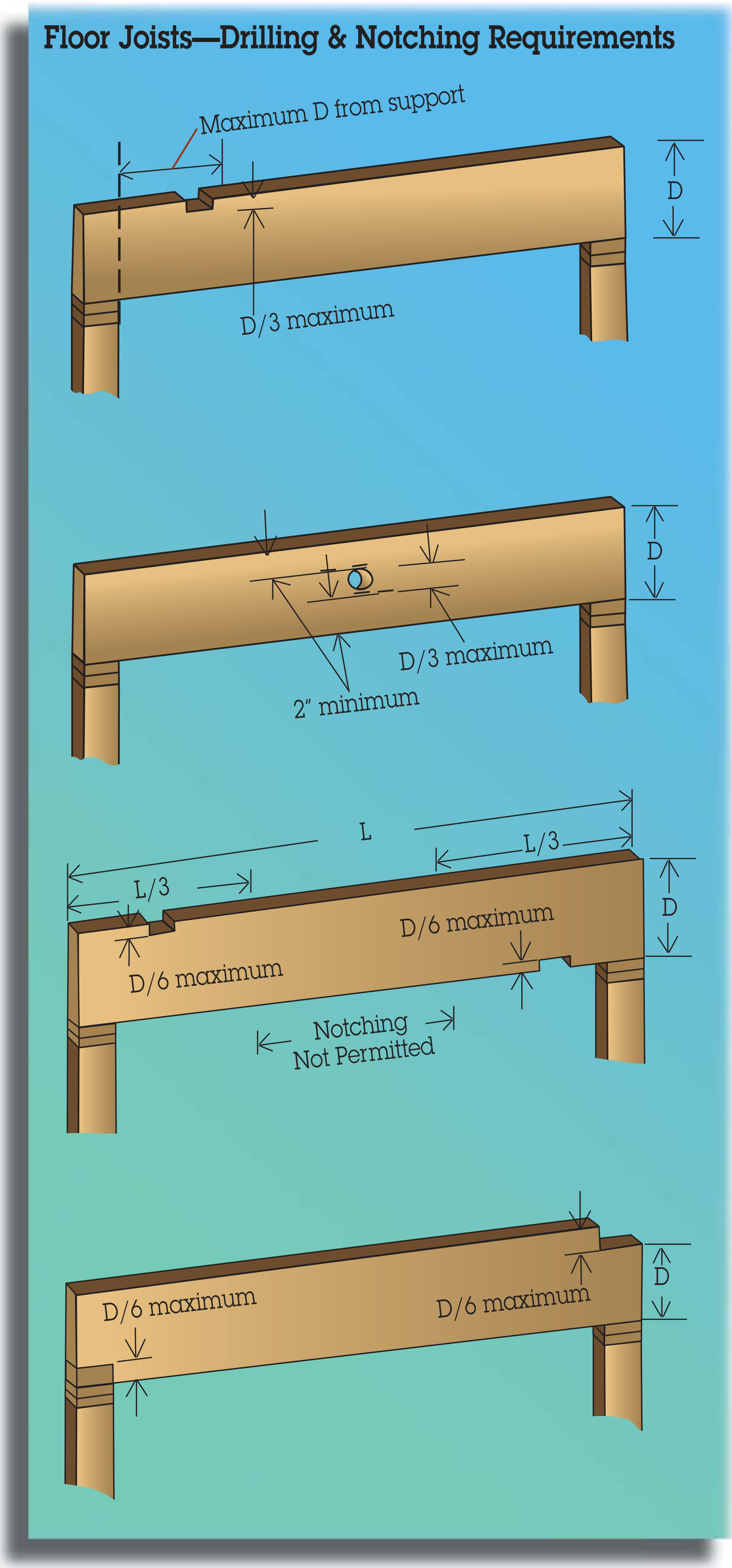
The "Framing Floor Openings" illustration shows the following code requirements and instructions related to framing around openings in floors.

- If the header joists are more than 4', the header joists and trimmer joists should be doubled.
- If the distance from the bearing point of a trimmer joist to the header joist is more than 3', the trimmer joists should be doubled.
- If the header joist is greater than 6', hangers must be used.
- If the tail joists are more than 12', use framing anchors or a 2 × 2 ledger.

The "Seismic Floor Opening Framing" illustration shows what to do if you are building in IRC seismic design categories B, C, D, or E and the opening is greater than 4' perpendicular to the joists. In such cases, you must provide blocking beyond the headers, and metal ties must be used to connect the headers with the blocks.

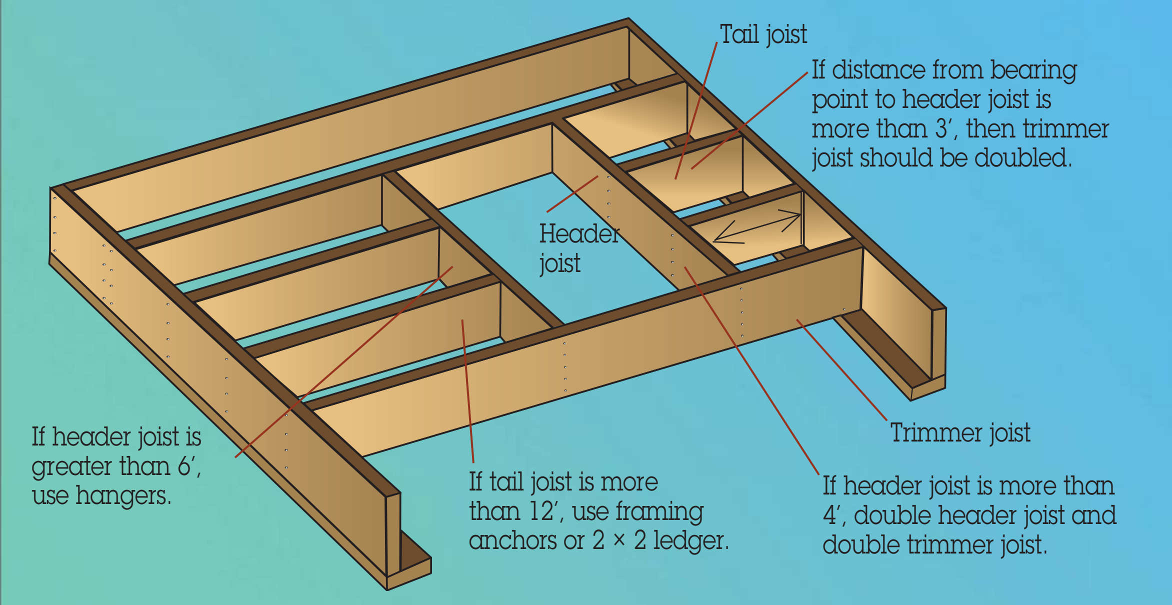
Floor Joists—Anchor or Ledger



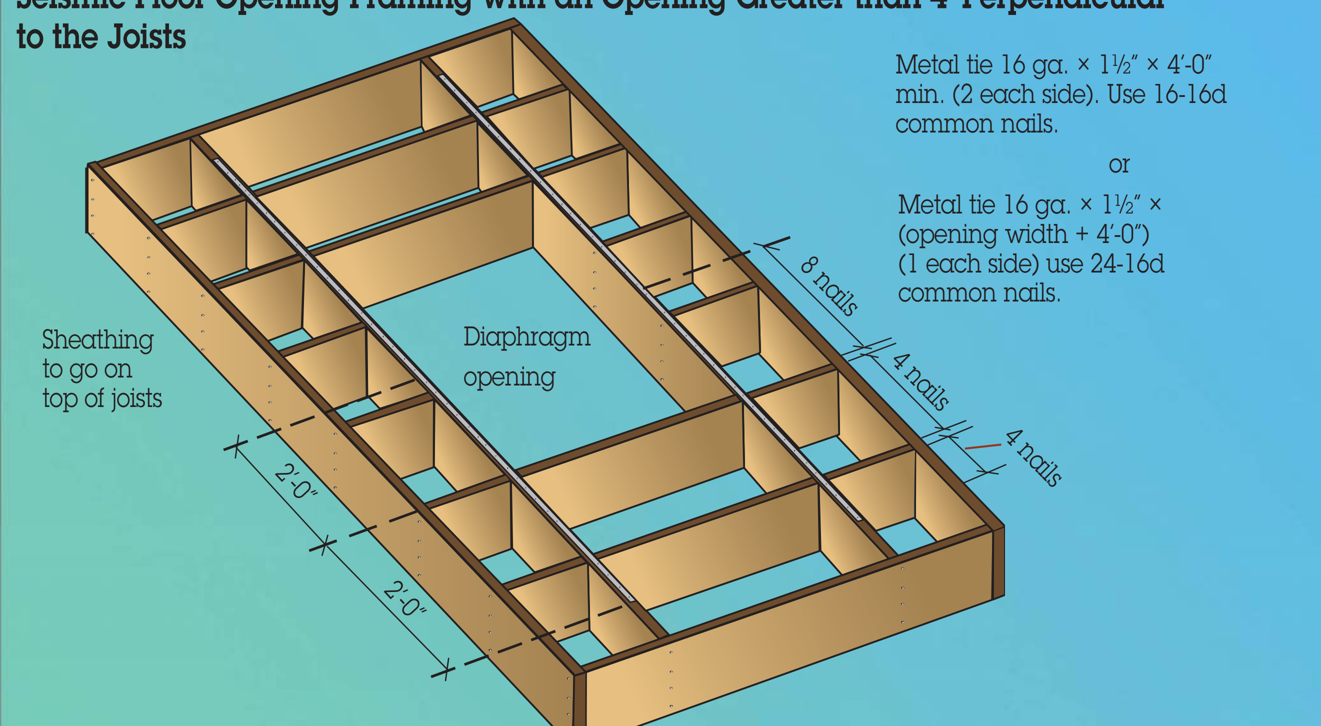


Floor Joists—Drilling & Notching Requirements
Maximum D from support
D
D/3 maximum
D
D/3 maximum
2" minimum
L
L/3
L/3
D
D/6 maximum
D/6 maximum
Notching Not Permitted
D/6 maximum
D/6 maximum
D

Framing Floor Openings



Seismic Floor Opening Framing with an Opening Greater than 4' Perpendicular to the Joists



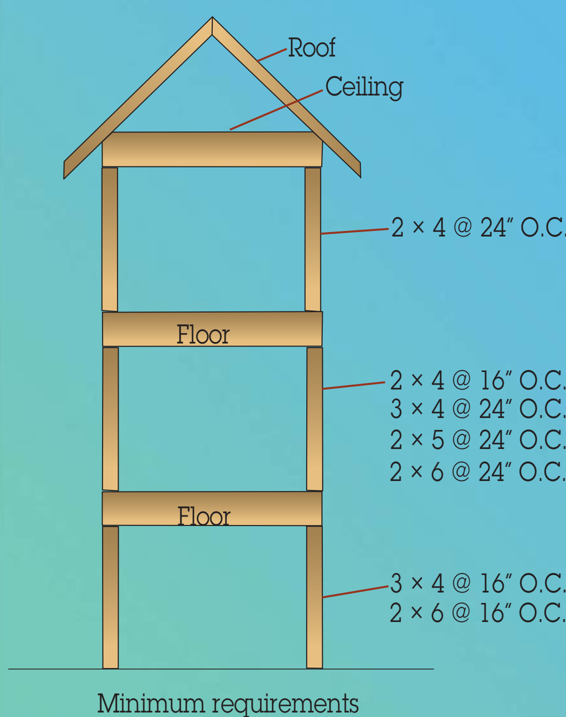
From the IBC Code; this information is not listed in the IRC.

Wall Framing

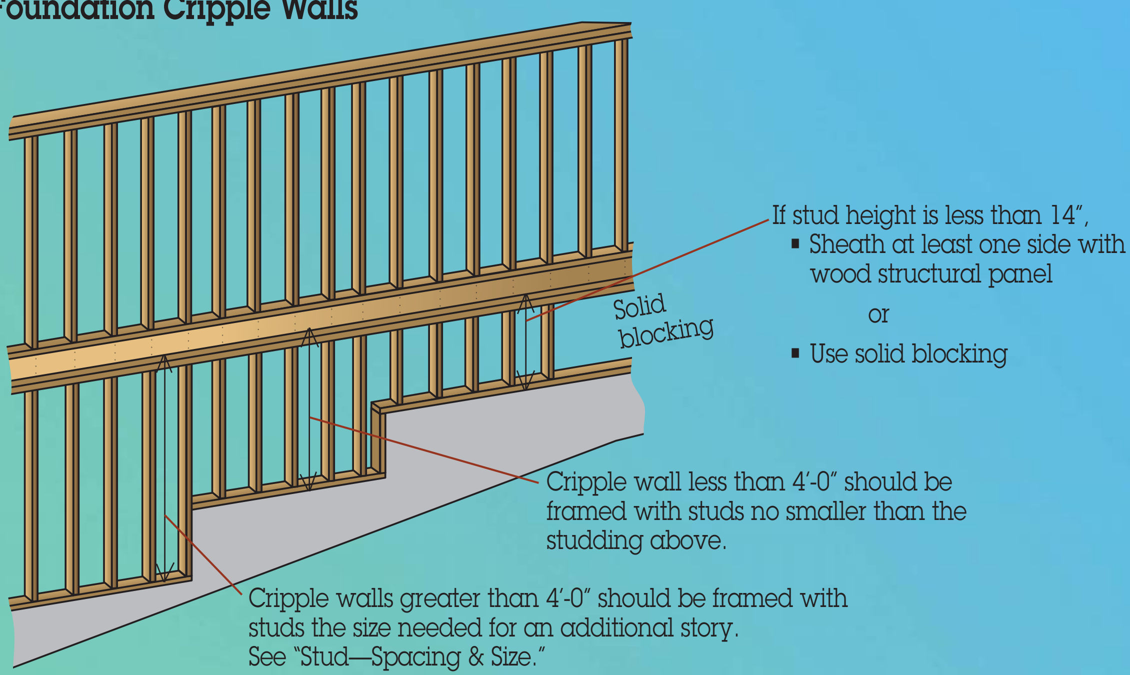
Stud spacing should be shown on the plans, but it is still good to be familiar with the code limitations. For 2 × 4 studs less than 10 feet tall, the maximum stud spacing is 24" O.C., provided the wall is supporting one floor or a roof and ceiling only. For the support of one floor, a roof, and ceiling, 16" O.C. is the maximum. To support two floors, a roof, and a ceiling with a maximum spacing of 16" O.C. and height of 10', a minimum of 3 × 4 studs must be used. If studs are 2 × 6, a wall can support one floor, a roof, and ceiling at 24" O.C., or two floors, a roof, and ceiling at 16" O.C. Again, this stud spacing only applies to walls that don't exceed 10' in height. (See "Stud—Spacing and Size" illustration.)

Cripple walls less than 4' in height should be framed with studs at least as big as those used in the walls above them. If the cripple walls are higher than 4', then the studs need to be at least the size required for supporting an additional floor level (as described in previous paragraph). (See "Foundation Cripple Walls" illustration.)

Stud—Spacing and Size



Foundation Cripple Walls



Double plates are needed on top plates for bearing and exterior walls. The end joints of the top plates and double plates should be offset by at least 48". The IRC allows a 24" offset at nonstructural interior walls. The end joints need to be nailed with at least eight 16d nails or twelve 3" × 0.131" nails on each side of the joint. A single top plate may be used if the plates are tied together at the joints, intersecting walls, and corners with 3" × 6" galvanized steel plates or the equivalent, and all rafters, joists, or trusses are centered over the studs. (See "Walls, Top and Double Plate" illustration.)

Allowable **drilling** and **notching** is different for bearing or exterior walls, and for *non-bearing* or interior walls. Bearing or exterior walls can be notched up to 25% of the width of the stud and drilled up to 40% of the stud provided that the hole is at least 5/8" away from the edge. With interior *non-bearing* walls, the percentages are 40% for notches and 60% for drilling. (See "Drilling & Notching Studs, Exterior & Bearing Walls" and "Drilling & Notching Studs, Interior Nonbearing Walls" illustrations later in this chapter.)

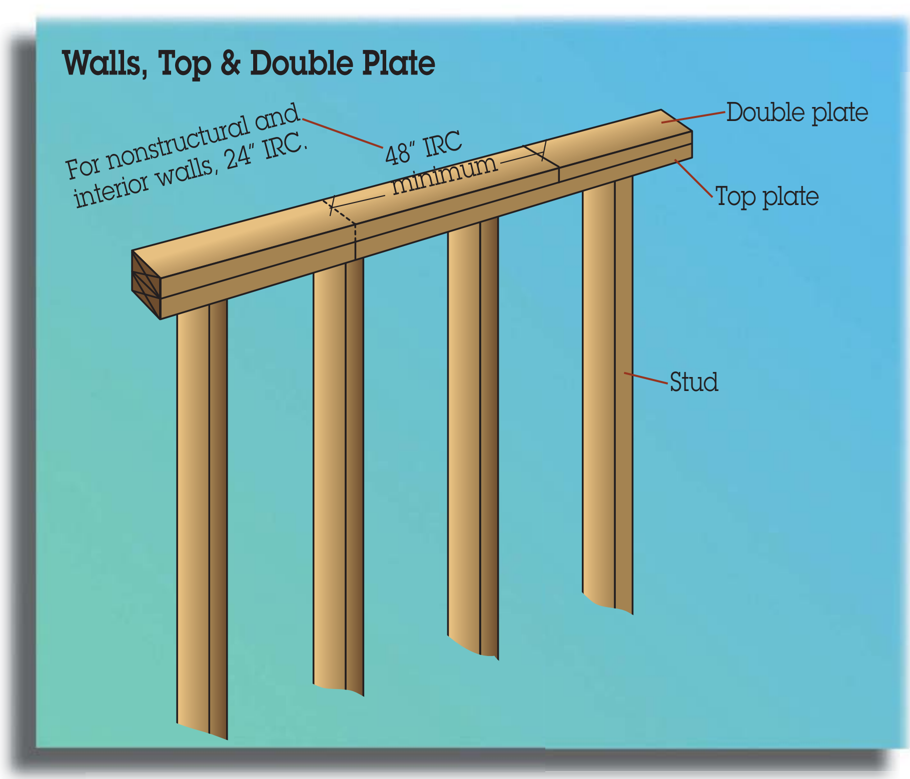
Header sizes for exterior and bearing walls should be specified on the plans. For *nonbearing* walls, a flat 2 × 4 may be used as a header for a maximum of up to 8' span where the height above the header to the top plate is 24" or less. (See "Header for Nonbearing Walls" illustration later in this chapter.)

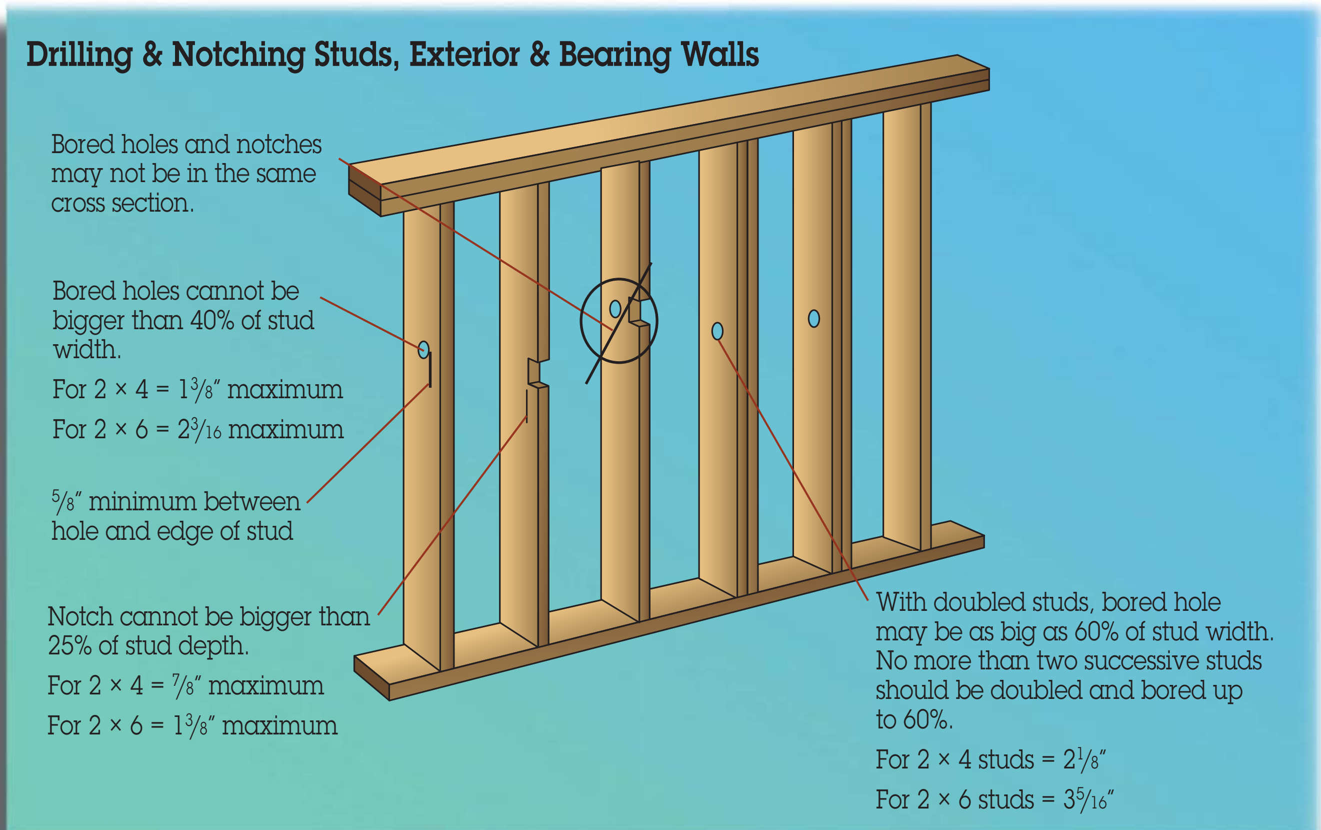
Fireblocking refers to material you install to prevent flames from traveling through concealed spaces between areas of a building. The location of fireblocks is sometimes difficult to understand. It helps to think of where flames would be able to go. A 1½"-thick piece of wood can create a fireblock. If you place a row of these blocks in a wall, you create a deterrent for the vertical spread of fire. Vertical and horizontal fireblocks are required in walls at least every 10'. (See "Fireblocking Vertical" and "Fireblocking Horizontal" illustrations later in this chapter.)

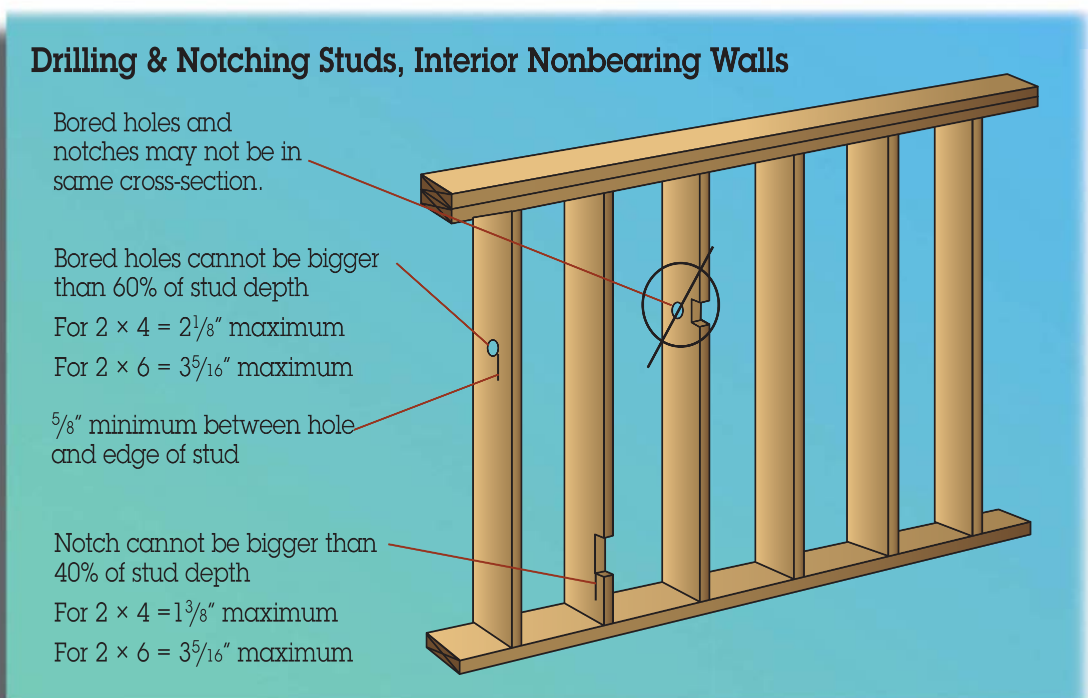
In a "party wall" construction, where you have two walls next to each other, you can create a fireblock by installing a stud in the space between the studs in the two adjoining walls. This creates a vertical fireblock. Note that ½" gypsum board can also be used to create this type of fireblock.

Fireblocking is required between walls, floors, ceilings, and roofs. Typically, the drywall covering creates this fireblock. If it doesn't, then fireblocking is needed. Where fireblocking is required behind the ledger, it can be installed at the interconnections of any concealed vertical and horizontal space like that which occurs at soffits, drop ceilings, or cove ceilings. (See "Fireblocking at Interconnections" illustration later in this chapter.)

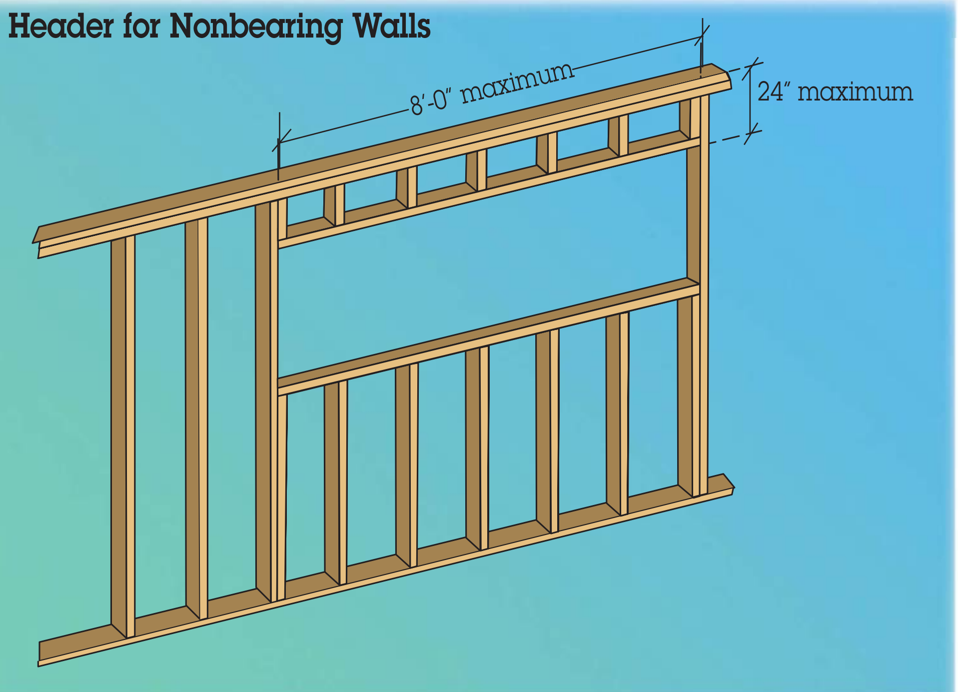
Stair stringers must be fireblocked at the top and bottom of each run and between studs along the stair stringers if the walls below the stairs are unfinished.



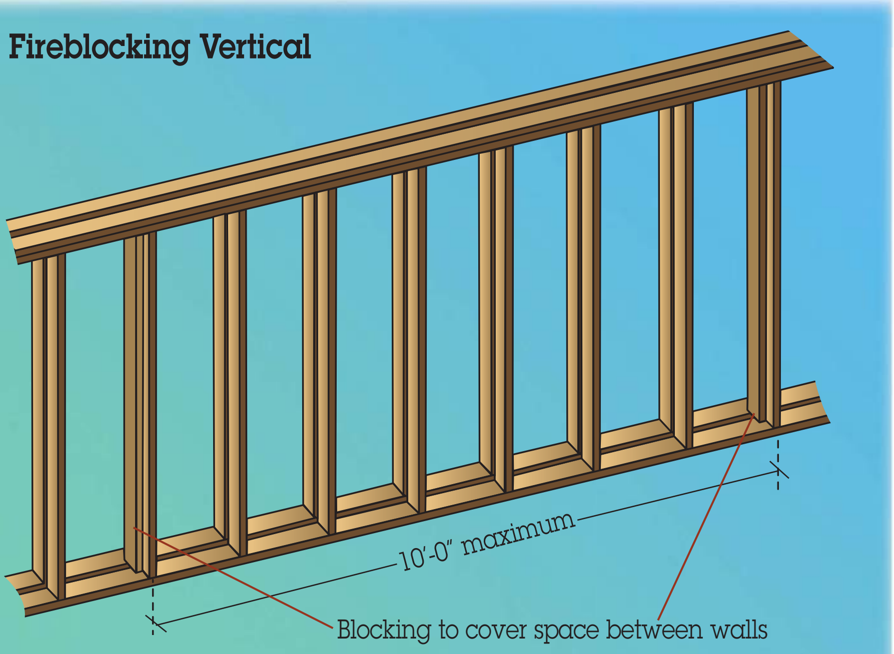

Drilling & Notching Studs, Exterior & Bearing Walls
Bored holes and notches may not be in the same cross section.
Bored holes cannot be bigger than 40% of stud width.
For 2 × 4 = 1 3/8″ maximum
For 2 × 6 = 2 3/16 maximum
5/8″ minimum between hole and edge of stud
Notch cannot be bigger than 25% of stud depth.
For 2 × 4 = 7/8″ maximum
For 2 × 6 = 1 3/8″ maximum
With doubled studs, bored hole may be as big as 60% of stud width. No more than two successive studs should be doubled and bored up to 60%.
For 2 × 4 studs = 2 1/8″
For 2 × 6 studs = 3 5/16″

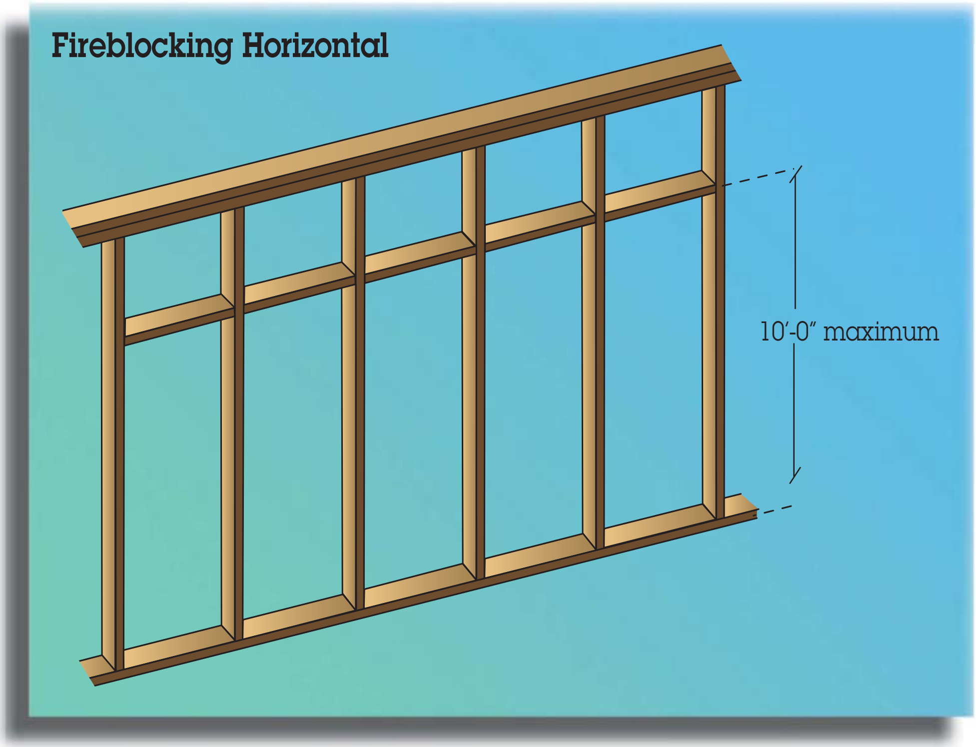

Drilling & Notching Studs, Interior Nonbearing Walls
Bored holes and notches may not be in same cross-section.
Bored holes cannot be bigger than 60% of stud depth
For 2 × 4 = 2 1/8″ maximum
For 2 × 6 = 3 5/16″ maximum
5/8″ minimum between hole and edge of stud
Notch cannot be bigger than 40% of stud depth
For 2 × 4 =1 3/8″ maximum
For 2 × 6 = 3 5/16″ maximum

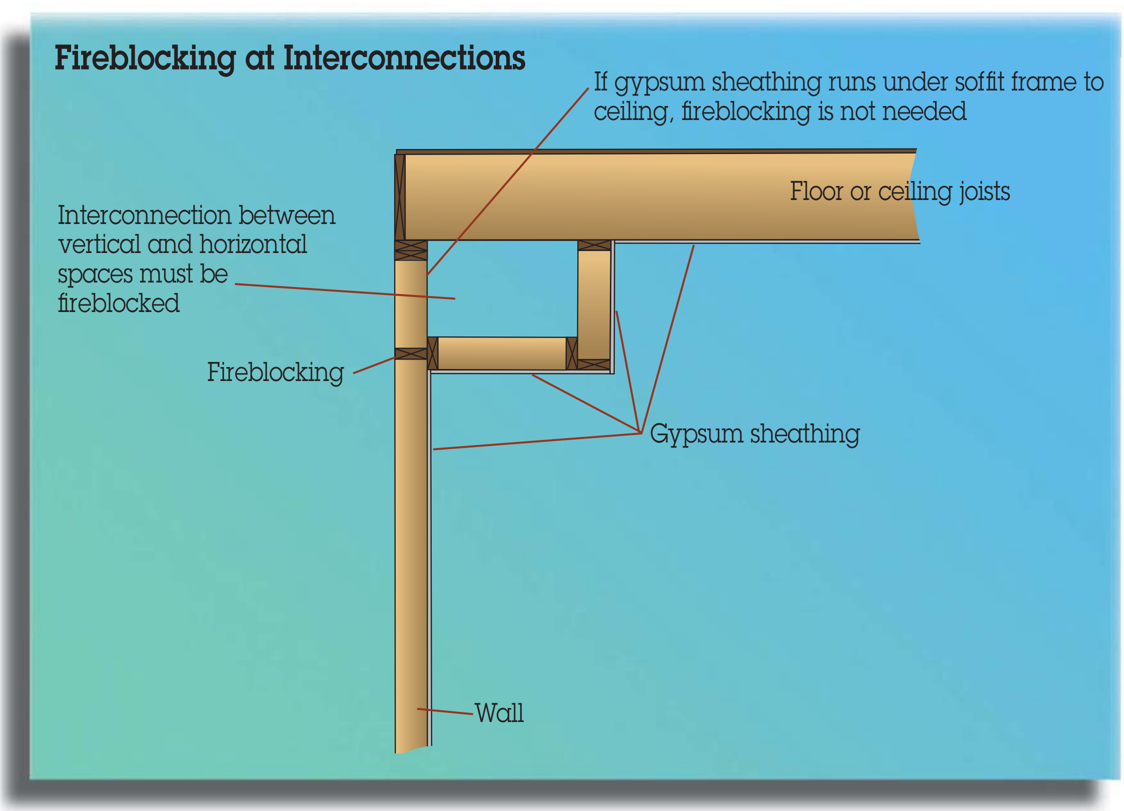
Header for Nonbearing Walls



Fireblocking Vertical




Fireblocking Horizontal
10'-0" maximum


Fireblocking at Interconnections
If gypsum sheathing runs under soffit frame to ceiling, fireblocking is not needed
Floor or ceiling joists
Interconnection between vertical and horizontal spaces must be fireblocked
Fireblocking
Gypsum sheathing
Wall

Wall Bracing

Wall bracing is needed to keep buildings from falling. Sheathing the exterior walls is a typical way to provide bracing. The architect, engineer, or whoever creates the plans will specify when any special bracing is needed. Although you don't need to know everything about wall bracing, it is good to have a basic understanding of it.

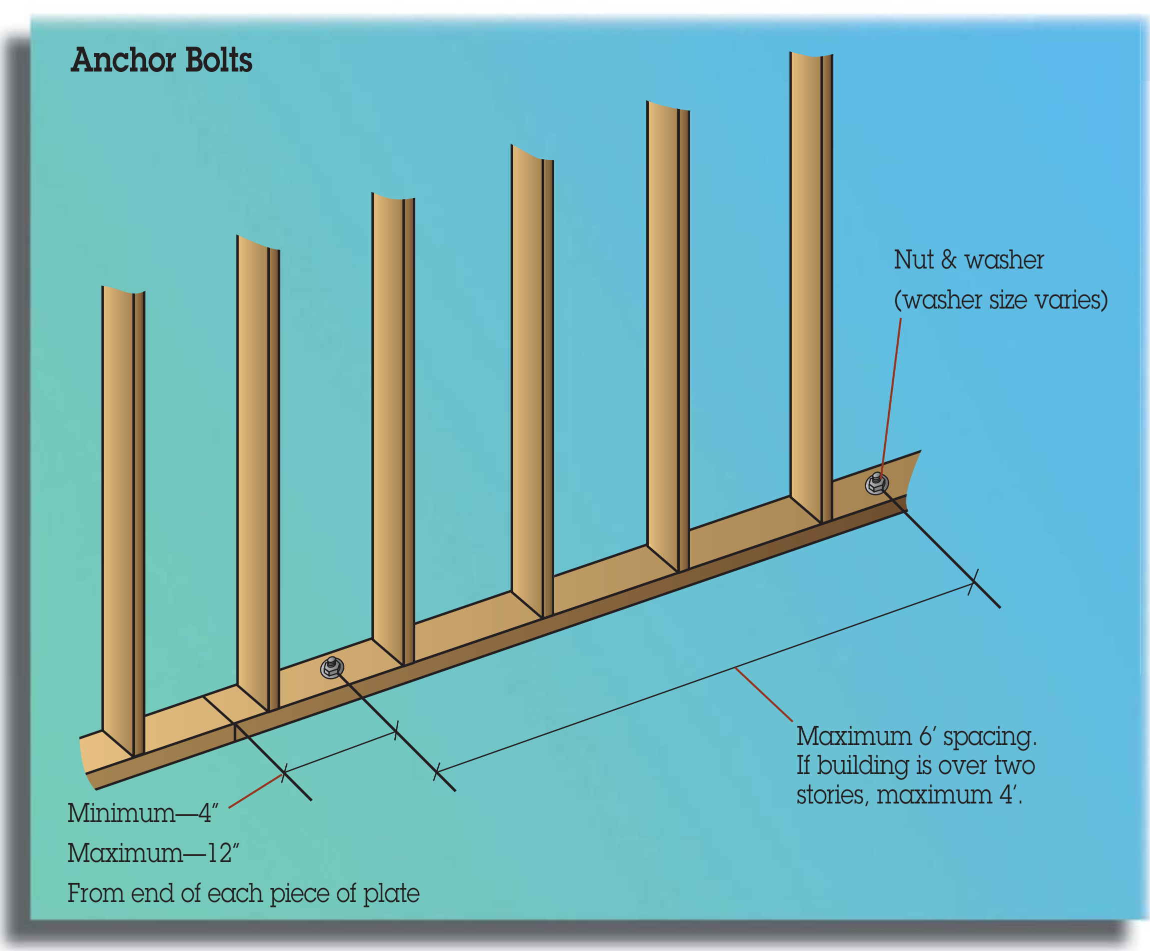
Two common exceptions to these methods are: (1) the short wall often used for garages, and (2) the 24" wide corner wall. Note that cripple walls have their own requirements.

The IBC states that braced wall panels must be clearly indicated on the plans. However, this is not always the case in the real world. Although shear walls are usually marked on the plans, braced wall panels often are not.

The IBC and IRC contain a table that shows braced wall panel limitations and requirements. The limitations are related to the seismic design category, and to how many stories are built on top of the walls.

Where braced wall lines rest on concrete or masonry foundations, they must have **anchor bolts** that are not less than ½" in diameter or a code-approved anchor strap. The anchor bolts or straps should be spaced not more than 6' apart (or not more than 4' apart if the building is over two stories).

Each piece of wall plate must contain at least two bolts or straps. There must be one between 4" and 12" from each end of each piece. A nut and washer must be tightened on each bolt. In IBC seismic design categories D, E, and F, engineered shear walls



require 0.229" × 3" × 3" plate washers. In IRC seismic design categories D_0, D_1, D_2, and E, braced walls require 0.229" × 3" × 3" plate washers. (See “Anchor Bolts” illustration.) These requirements also apply to townhouses in seismic design category C.

The eleven basic construction methods for braced wall panels are as follows:

1. LIB—Let-in-bracing
2. DWB—Diagonal wood boards
3. WSP—Wood structural panel
4. SFB—Structural fiberboard sheathing
5. GB—Gypsum board
6. PBS—Particleboard sheathing
7. PCP—Portland cement plaster
8. HPS—Hardboard panel siding
9. ABW—Alternate braced wall
10. PFH—Intermittent portal frame
11. PFG—Intermittent portal frame at garage

Rafter Framing

Ridge boards must be at least 1" nominal in width and must be as deep as the cut end of the rafter. Hip and valley rafters must be at least 2" nominal and must be as deep as the cut ends of the rafters connecting to the hip of the valley. **Gusset plates** as a tie between rafters may be used to replace a ridge board.

Rafters must have a bearing surface similar to that of joists at their end supports. Bearing needs to be 1½" on wood or metal and not less than 3" on masonry or concrete.

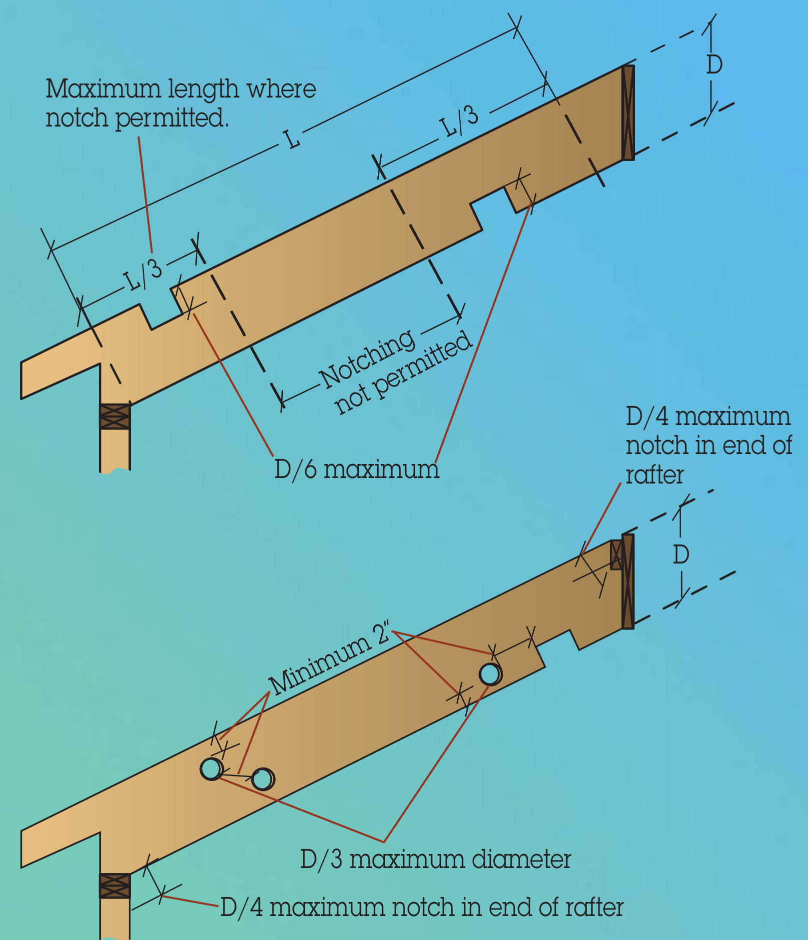
Drilling and notching have the same limitations for rafters as they do for floor joists. (See “Rafter Drilling & Notching” illustration.)

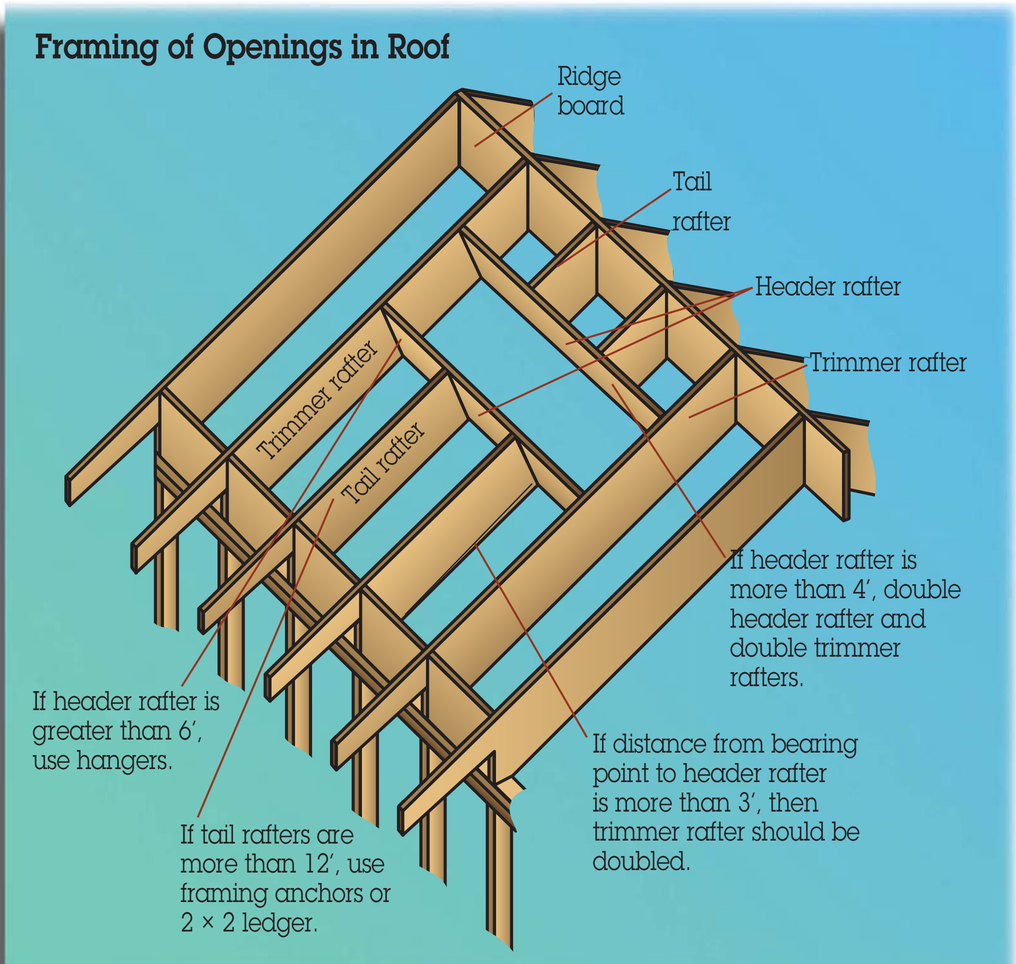
To prevent rotation of rafter framing members, **lateral support** or **blocking** must be provided for rafters and ceiling joists larger than 2 × 10s.

Bridging must be provided for roofs or ceilings larger than 2 × 12. The bridging may be solid blocking, diagonal bridging, or a continuous 1" × 3" wood strip nailed across the ceiling joists or rafters at intervals not greater than 8'. Bridging is not needed if the ceiling joists or rafters are held in line for the entire length with, for example, sheathing on one side and gypsum board on the other.

When rafters are used to frame the roof, the walls that the rafters bear on must be tied together by a connection to keep them from being pushed out. If these walls are not tied together, then the ridge board must be supported by or framed as a beam in order to support the ridge. Ceiling joists are typically used to tie the walls together. The ceiling joists must be tied to the rafters, the walls, and any lapping ceiling joists. (See ceiling joists.)

Rafter Drilling & Notching





The IRC calls for a **minimum ceiling clearance** of 7'. The IBC requires 7'-6" with the exception of bathrooms, kitchens, laundry, and storage rooms, where it can be 7'.

There are three exceptions to this rule. First, beams or girders can project 6" below the required ceiling height if they are spaced more than 4' apart. The second exception is for basements without habitable spaces. These may have a minimum height of 6'-8" and may have beams, girders, ducts, and other obstructions at 6'-4" in height. The third exception is for a sloped ceiling. Fifty percent of the sloped ceiling room area can be less than the minimum ceiling height. However, any portion of the room less than 5' in height cannot be included in figuring the room area. (See “Ceiling Heights” illustration later in this chapter.)

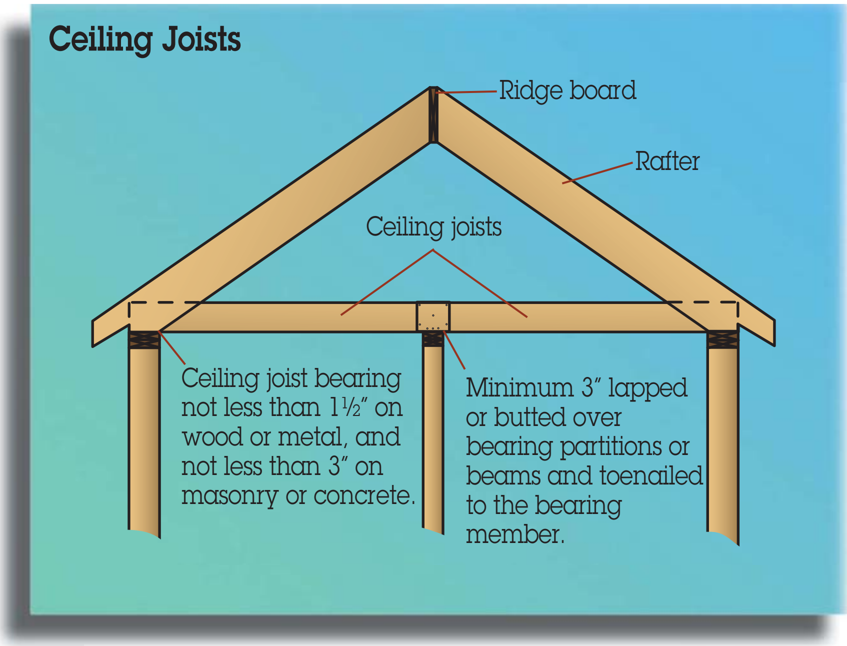
Ceiling Framing

Ceiling joists must have **bearing support** similar to that of rafters. The bearing must be 1½" on wood or metal, and not less than 3" on masonry or concrete.

The most important thing to remember about ceiling joists is that if they are used to tie the rafter-bearing walls at opposite ends of the building, then those joists must be **securely attached** to the walls, to the rafters, and to each other at the laps. If the ceiling joists do not run parallel with the rafters, an equivalent rafter tie must be installed to provide a continuous tie across the building.

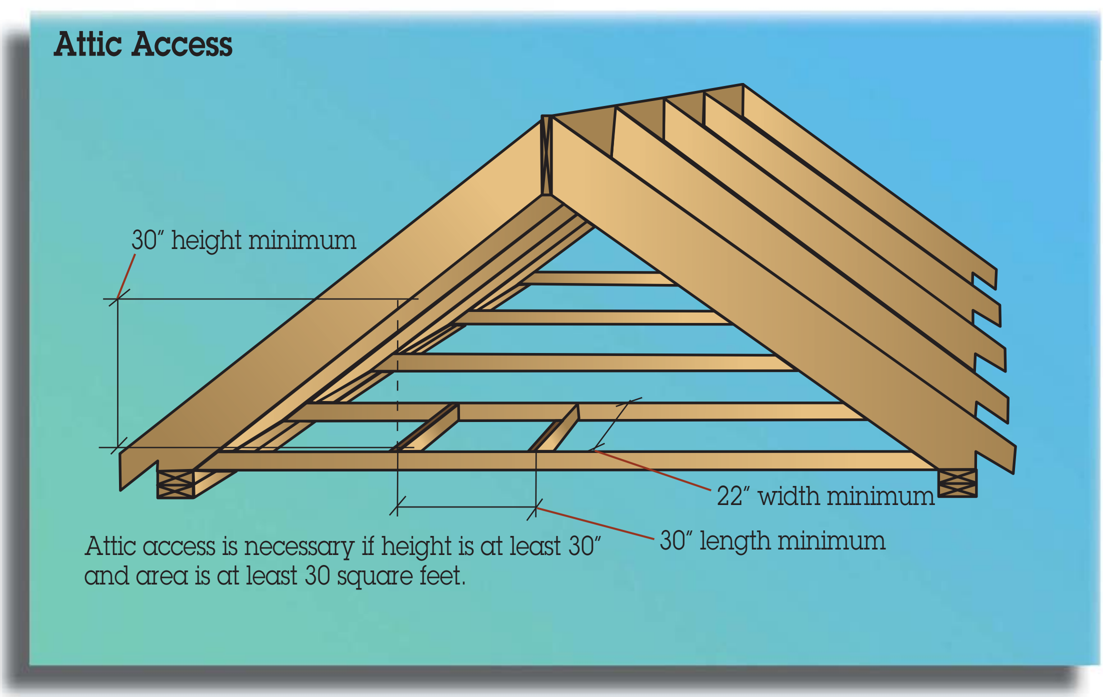
Truss Framing

Trusses are an engineered product. This means that an engineer or design professional must design them for each job to form a roof/ceiling system. Components and members of the trusses **should not be notched**, **cut**, **drilled**, **spliced**, or **altered** in any way without the approval of a registered design professional.

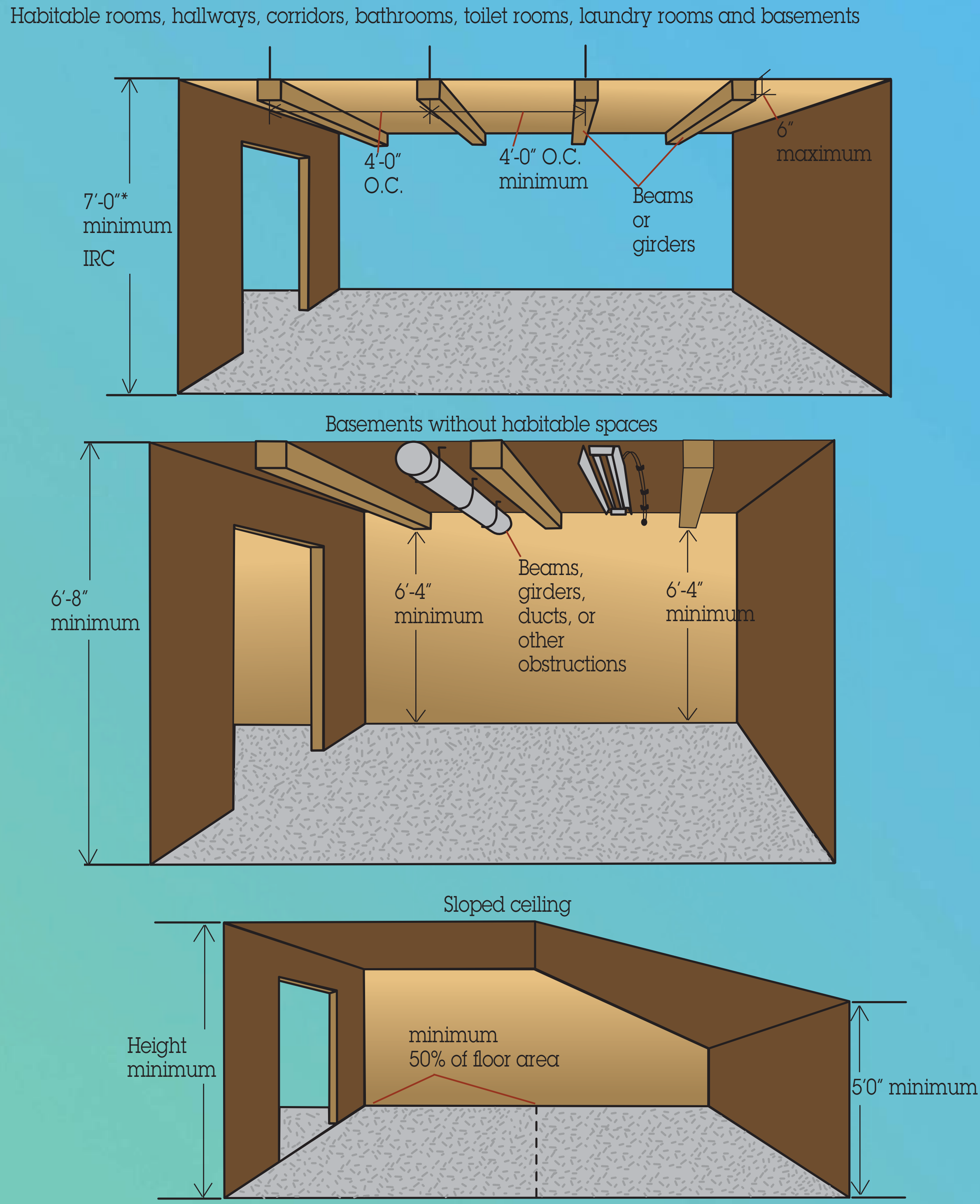


Attic Access & Ceiling Heights

An attic access must be provided if the attic area exceeds 30 square feet, and the height is at least 30". This opening must be at least 22" × 30", and there must be a height of at least 30" at the access opening. (See "Attic Access" illustration below.)



Ceiling Heights



*7′-6″ required by IBC for occupiable spaces, habitable spaces, and corridor.
7′-0″ required for bathrooms, toilet rooms, kitchens, storage rooms, and laundry rooms.

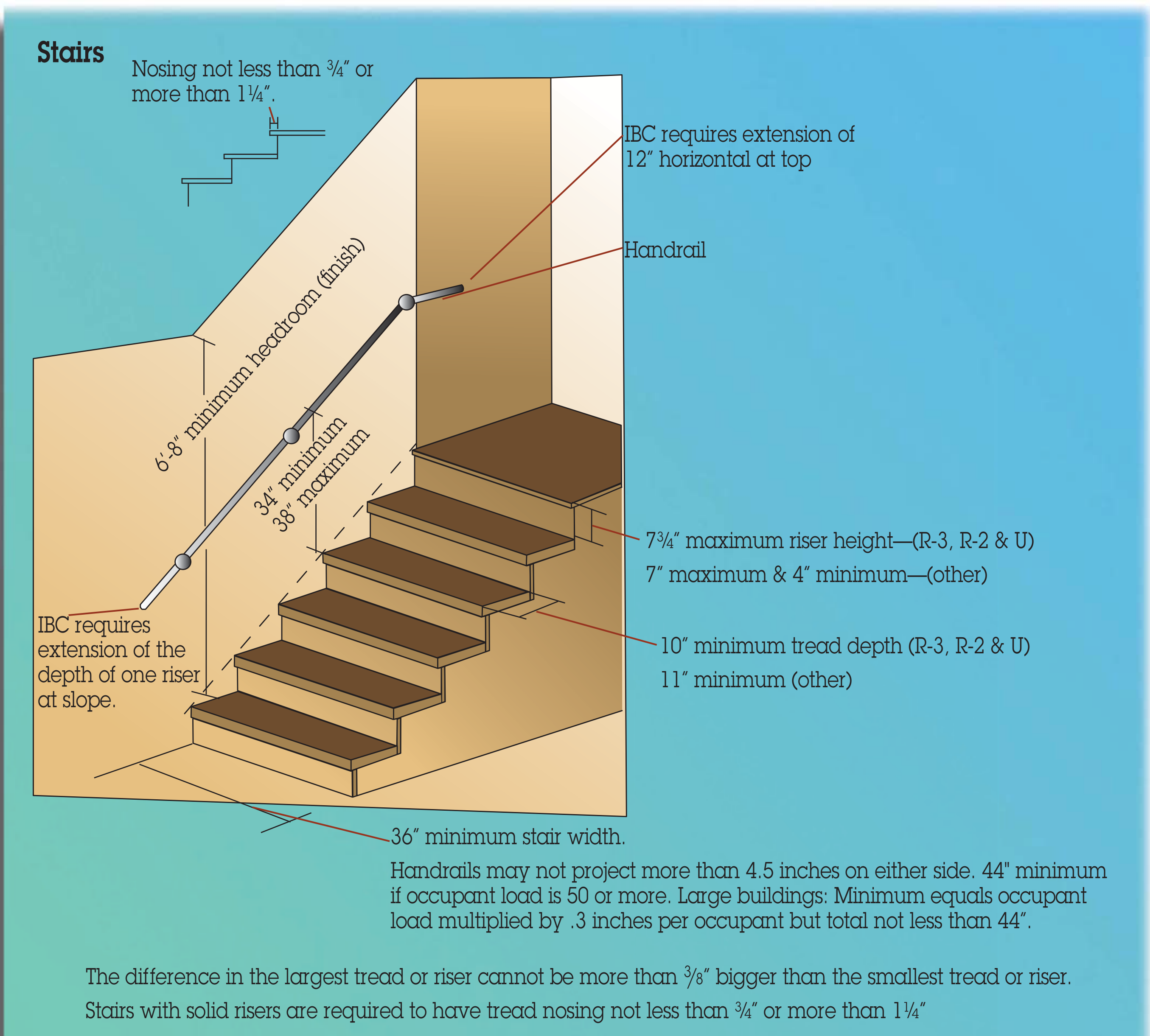
Stair & Ramp Framing

The **width** of stairs must be a minimum of 36" from finish to finish. Handrails may project into the 36" a maximum of 4½" on each side. (See "Stairs" illustration.)

Two sets of **tread** and **riser dimensions** apply to minimum and maximum requirement. One set is for Group R-3, Group R-2, and Group 4 (houses, apartments, dormitories, non-transient housing). The other is for all other groups. The first set requires a maximum riser height of 7¾" and a minimum tread depth of 10", while the second requires a maximum riser height of 7", a minimum riser height of 4", and a minimum tread depth of 11".

The **variation** in riser height within any flight of stairs must not be more than 3/8" from finish tread to finish tread. The variation in tread depth within any flight of stairs cannot be more than 3/8" from the finish riser to the nose of the tread.

Headroom for stairways must have a minimum finish clearance of 6'-8", measured vertically from a line connecting the edge of the nosings.



Handrails for stairs must have a height of no less than 34" and no more than 38", measured vertically from a line created by joining the nosing on the treads.

Stairway **landings** must be provided for each stairway at the top and bottom. The width each way of the landing must not be less than the width of the stairway it serves. The landing's minimum dimension in the direction of travel cannot be less than 36", but does not need to be greater than 48" for a stair having a straight run. (See "Stair Landing" illustration.)

Circular stairways should have a minimum tread depth at a point 12" from the edge of the tread at its narrowest point of not less than 11". According to both the IRC and the IBC, the minimum depth at any point must be 6". (See "Circular Stairs" illustration.)

Spiral stairways must have a minimum width of 26". Each tread must have a minimum tread width of 7½" at a point 12" from the narrow edge of the tread. The rise must be no more than 9½". All treads must be identical. The headroom is a minimum of 6'-6". (See "Spiral Stairs" illustration.)

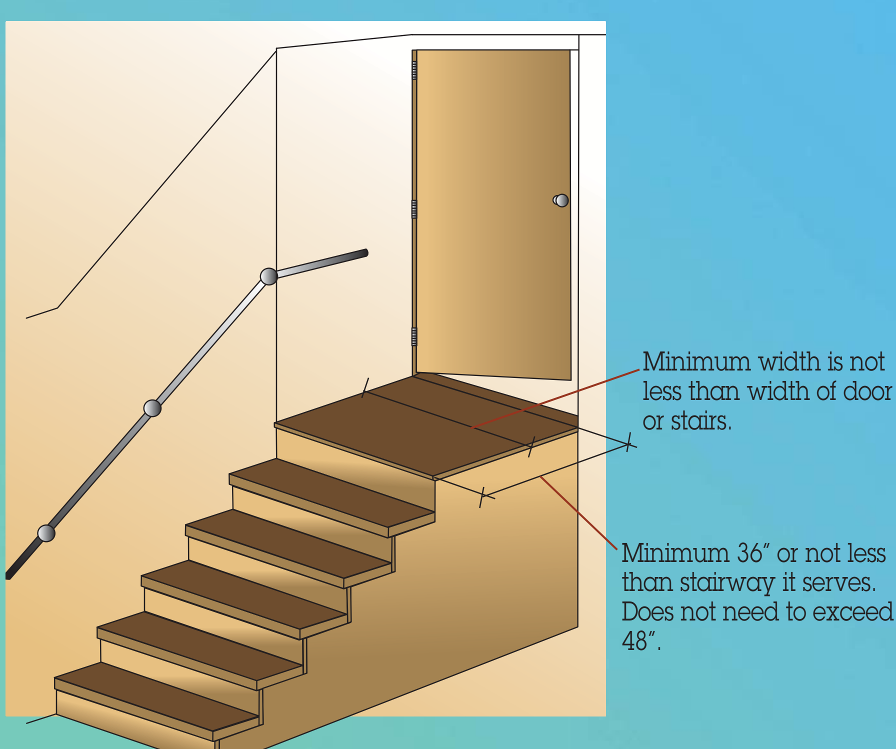
The maximum slope on a **ramp** is 8%, or one unit of rise for 12 units of run. Some exceptions (where technically infeasible) are available for slope of 1 unit vertical in 8 units horizontal—12-½%. Handrails must be provided when the slope exceeds 8.33%, or one unit of rise and 12 units of run.

The **minimum headroom** on any part of a ramp is 6'-8".

A minimum 36" × 36" **landing** is required at the top and bottom of a ramp and where there is any door, or where the ramp changes direction. The actual minimum landing dimensions will depend on the building use and occupant capacity. This minimum does not apply to non-accessible housing.

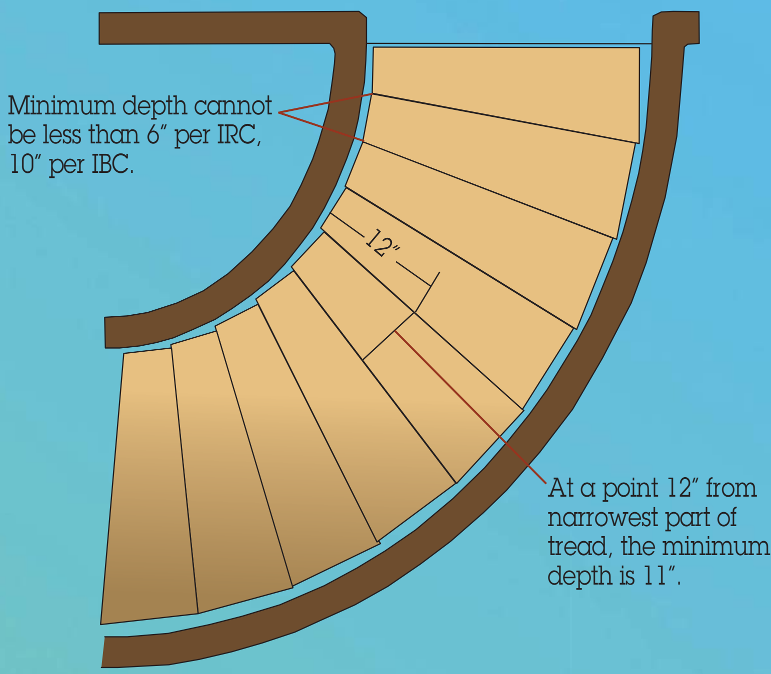
The maximum **total rise** of any ramp cannot be more than 30" between level landings. (See "Ramps" illustration later in this chapter.)

Stair Landing

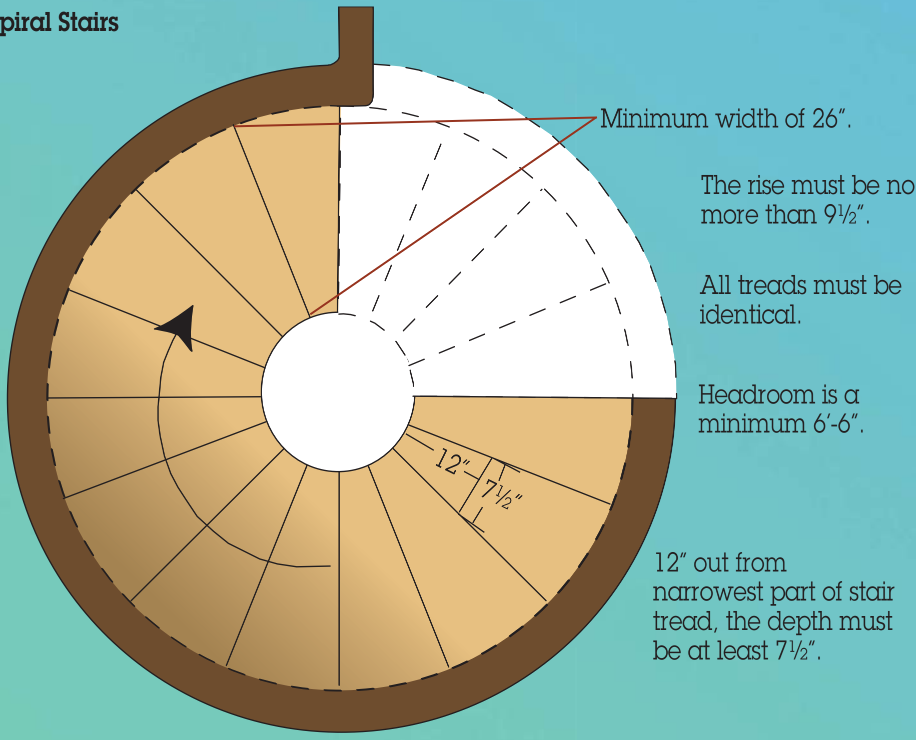


Circular & Spiral Stairs

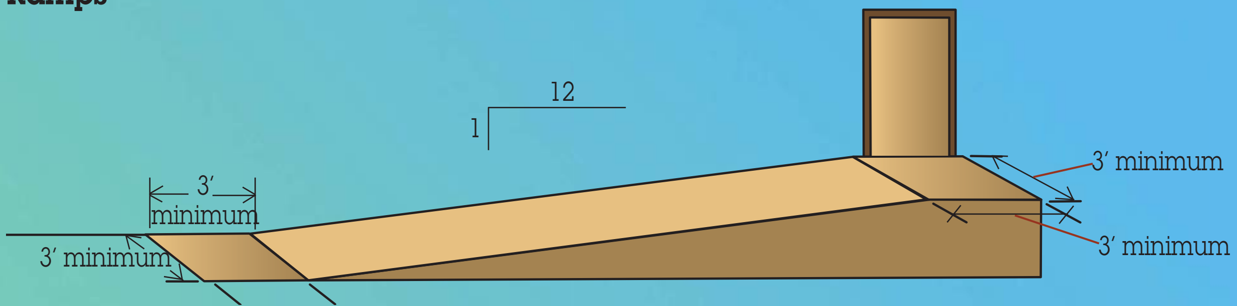
Circular Stairs



Spiral Stairs



Ramps



Some exceptions (where technically feasible) are available for 1 unit vertical in 8 units horizontal slope—12.5%.

Handrails are required for slopes greater than 1 unit rise in 12 units run (8.33%).

If the building's occupancy capacity is more than 50, then the minimum landing dimensions are 44″. The actual minimum landing dimensions will depend on the building use and occupant capacity.

Ventilation

Ventilation is required so that condensation does not occur on the structural wood, causing dry rot and the deterioration of the building. Cross ventilation is required in crawl spaces, attics, and in enclosed rafter spaces. In rafter spaces between the insulation and the roof sheathing, there must be at least 1" clear space.

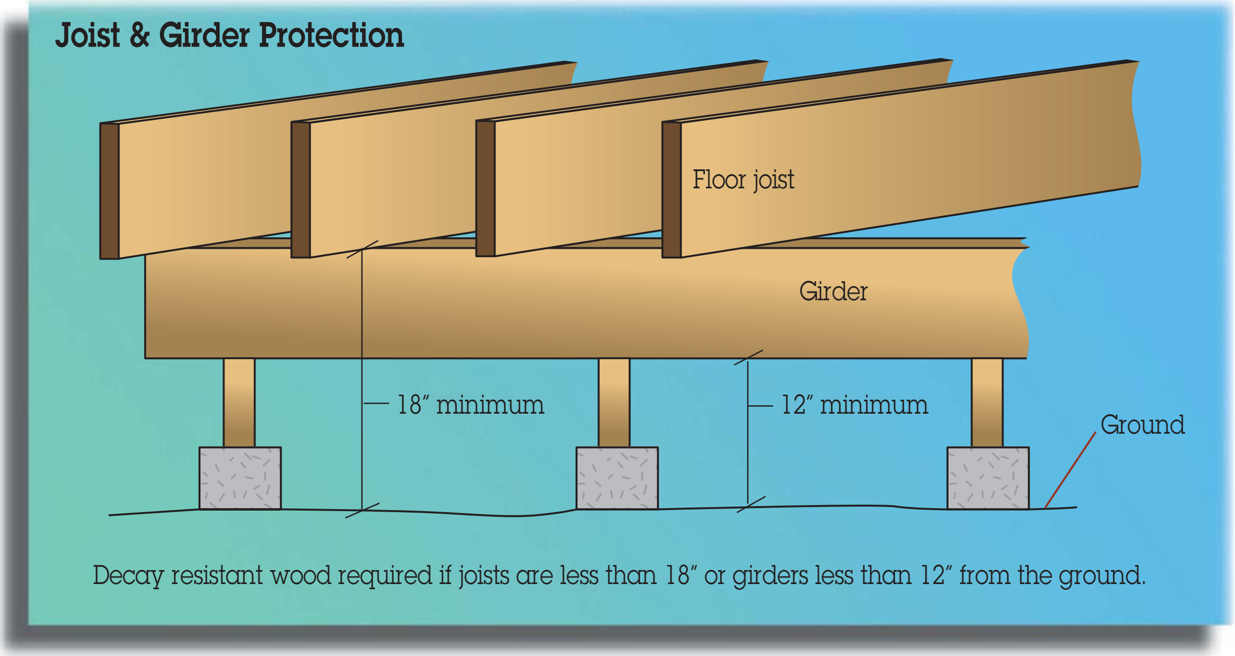
The **total area** of the space to be ventilated cannot be more than 150 times the size of the area of the venting. (Both are measured in square feet.)

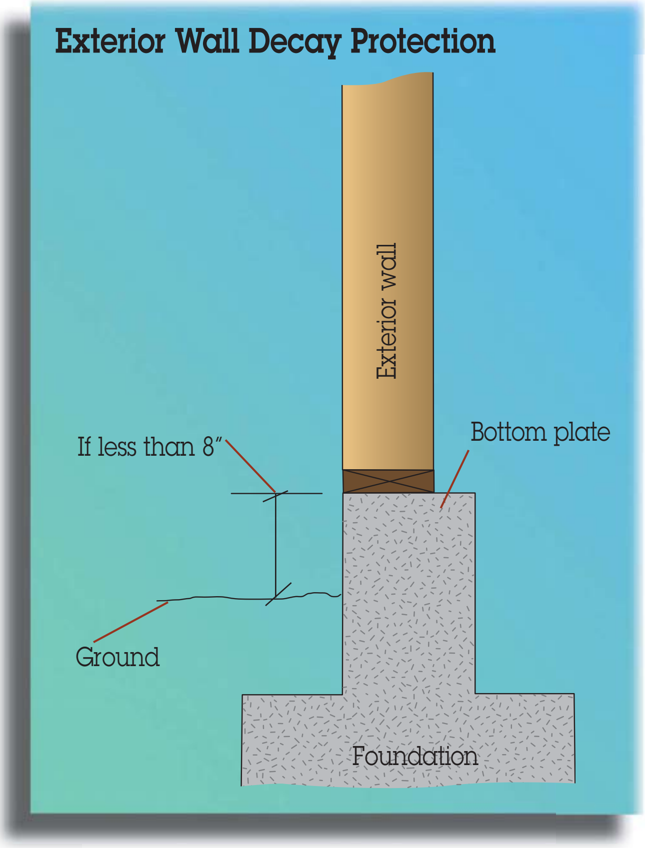
Protection from Decay

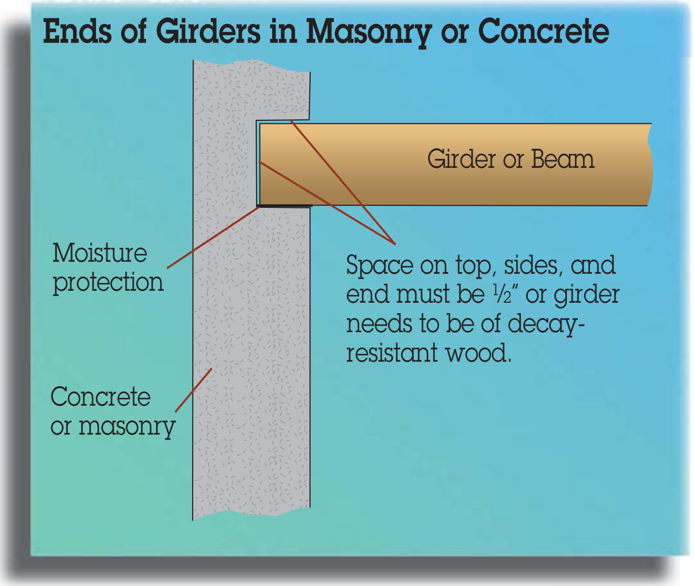
Moisture and warm air are catalysts of fungus, which causes dry rot that can destroy a building. In addition to calling for ventilation to control moisture, the code also requires decay-resistant wood wherever moisture can come in contact with structural wood. Some areas of the country are more conducive to decay than others. The code requires naturally durable wood or preservative-treated wood in the following situations:

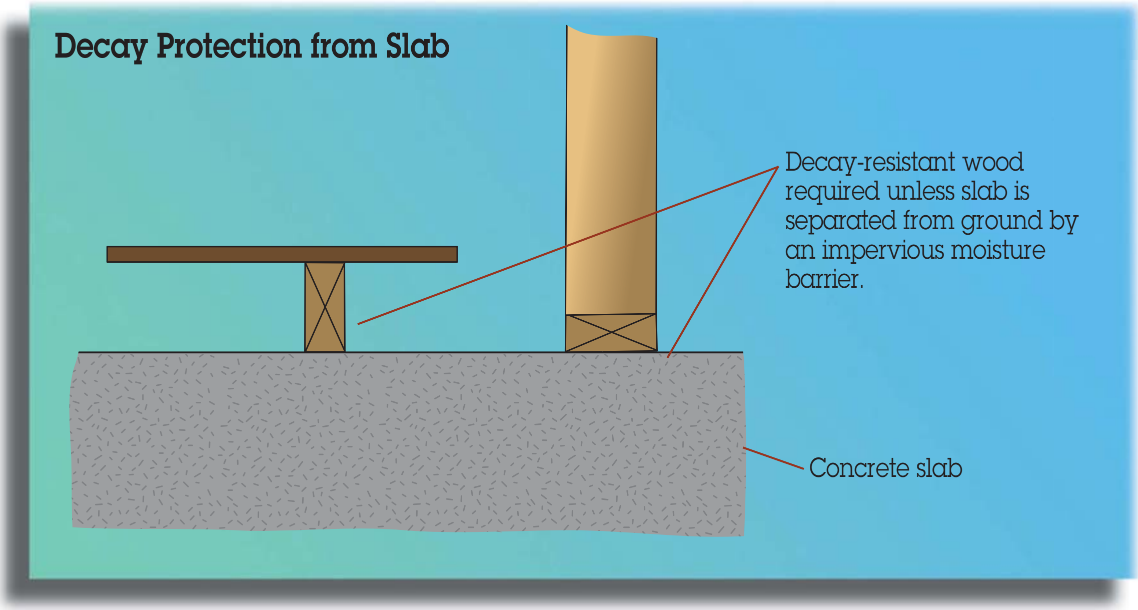
- Wood joist or the bottom of the wood floor structure if less than 18" from exposed ground. (See "Joists & Girder Protection" illustration.)
- Wood girders if closer than 12" from exposed ground.
- Wall plates, mudsills, or sheathing that rest on concrete or masonry exterior walls less than 8" from exposed ground. (See "Exterior Wall Decay Protection" illustration.)
- Sills or sleepers that rest on a concrete or masonry slab in direct contact with the ground, unless separated from the slab by an impervious moisture barrier. (See "Decay Protection from Slab" illustration later in this chapter.)
- The ends of wood girders entering exterior masonry or concrete walls having less than ½" clearance on tops, sides, and ends. (See "Ends of Girders in Masonry or Concrete" illustration.)

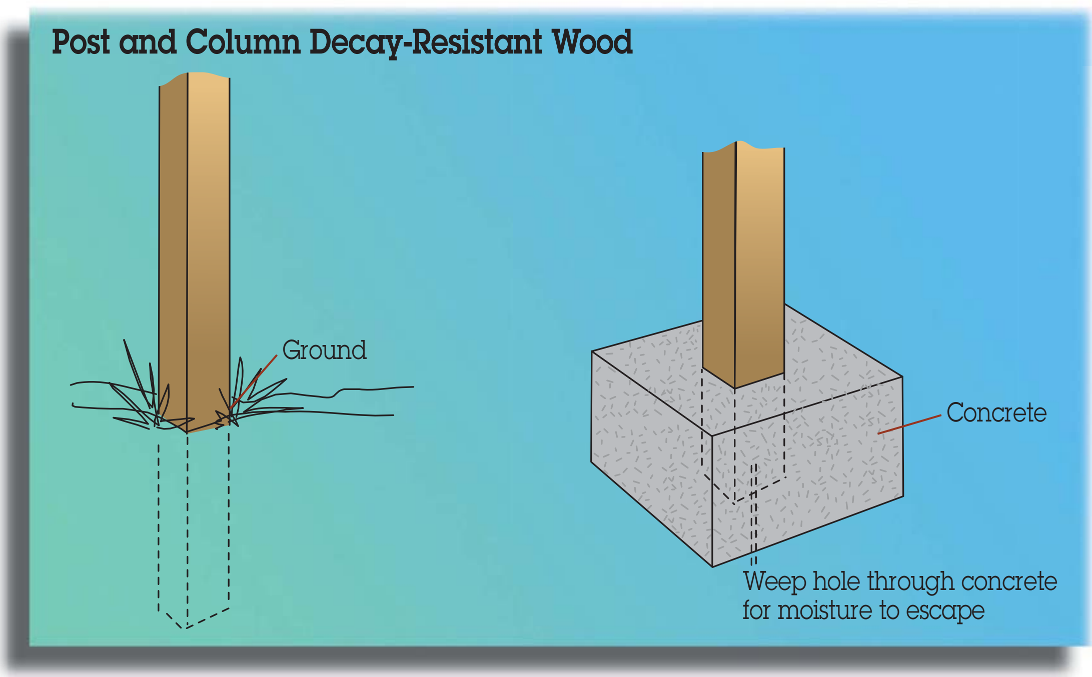
- Wood furring strips or framing members attached directly to the interior of exterior concrete or masonry walls below grade.
- Wood siding less than 6" from exposed ground.
- Posts or columns that support permanent structures and are themselves supported by a masonry concrete slab or footing in direct contact with the ground. (See “Post and Column Decay-Resistant Wood” illustration.)











Nailing

Nailing is one of the most important parts of framing. Table 2304.9.1, Fastening Schedule (see IBC Nailing Table), is taken directly from the IBC 2009. The table shows use of alternate nails. The 3" × 0.131" nail is the most common nail gun nail used for framing.

IBC Nailing Table

TABLE 2304.9.1
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
1. Joist to sill or girder	3 - 8d common ($2^{1}/_{2}$ 0.131) 3 - 3 0.131 nails 3 - 3 14 gage staples	toenail
2. Bridging to joist	2 - 8d common ($2^{1}/_{2}$ × 0.131) 2 - 3 0.131 nails 2 - 3 14 gage staples	toenail each end
3. 1 6 subfloor or less to each joist	2 - 8d common ($2^{1}/_{2}$ 0.131)	face nail
4. Wider than 1 6 subfloor to each joist	3 - 8d common ($2^{1}/_{2}$ 0.131)	face nail
5. 2 subfloor to joist or girder	2 - 16d common ($3^{1}/_{2}$ 0.162)	blind and face nail
6. Sole plate to joist or blocking	16d ($3^{1}/_{2}$ 0.135) at 16 o.c. 3 0.131 nails at 8 o.c. 3 14 gage staples at 12 o.c.	typical face nail
Sole plate to joist or blocking at braced wall panel	3 - 16d ($3^{1}/_{2}$ 0.135) at 16 4 - 3 0.131 nails at 16 4 - 3 14 gage staples per 16	braced wall panels
7. Top plate to stud	2 - 16d common ($3^{1}/_{2}$ 0.162) 3 - 3 0.131 nails 3 - 3 14 gage staples	end nail
8. Stud to sole plate	4 - 8d common ($2^{1}/_{2}$ 0.131) 4 - 3 0.131 nails 3 - 3 14 gage staples	toenail
	2 - 16d common ($3^{1}/_{2}$ 0.162) 3 - 3 0.131 nails 3 - 3 14 gage staples	end nail
9. Double studs	16d ($3^{1}/_{2}$ 0.135) at 24 o.c. 3 0.131 nail at 8 o.c. 3 14 gage staple at 8 o.c.	face nail
10. Double top plates	16d ($3^{1}/_{2}$ 0.135) at 16 o.c. 3 0.131 nail at 12 o.c. 3 14 gage staple at 12 o.c.	typical face nail
Double top plates	8-16d common ($3^{1}/_{2}$ 0.162) 12-3 0.131 nails 12-3 14 gage staples	lap splice
11. Blocking between joists or rafters to top plate	3 - 8d common ($2^{1}/_{2}$ 0.131) 3 - 3 0.131 nails 3 - 3 14 gage staples	toenail
12. Rim joist to top plate	8d ($2^{1}/_{2}$ 0.131) at 6 o.c. 3 0.131 nail at 6 o.c. 3 14 gage staple at 6 o.c.	toenail
13. Top plates, laps and intersections	2 - 16d common ($3^{1}/_{2}$ 0.162) 3 - 3 0.131 nails 3 -3 14 gage staples	face nail
14. Continuous header, two pieces	16d common ($3^{1}/_{2}$ 0.162)	16 o.c. along edge
15. Ceiling joists to plate	3 - 8d common ($2^{1}/_{2}$ 0.131) 5 - 3 0.131 nails 5 - 3 14 gage staples	toenail
16. Continuous header to stud	4 - 8d common ($2^{1}/_{2}$ 0.131)	toenail

(continued)

TABLE 2304.9.1—continued
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
17. Ceiling joists, laps over partitions (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common ($3^1/_2$ 0.162) minimum, Table 2308.10.4.1 4 - 3 0.131 nails 4 - 3 14 gage staples	face nail
18. Ceiling joists to parallel rafters (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common ($3^1/_2$ 0.162) minimum, Table 2308.10.4.1 4 - 3 0.131 nails 4 - 3 14 gage staples	face nail
19. Rafter to plate (see Section 2308.10.1, Table 2308.10.1)	3 - 8d common ($2^1/_2$ 0.131) 3 - 3 0.131 nails 3 - 3 14 gage staples	toenail
20. 1 diagonal brace to each stud and plate	2 - 8d common ($2^1/_2$ 0.131) 2 - 3 0.131 nails 3 - 3 14 gage staples	face nail
21. 1 8 sheathing to each bearing	3 - 8d common ($2^1/_2$ 0.131)	face nail
22. Wider than 1 8 sheathing to each bearing	3 - 8d common ($2^1/_2$ 0.131)	face nail
23. Built-up corner studs	16d common ($3^1/_2$ 0.162) 3 0.131 nails 3 14 gage staples	24 o.c. 16 o.c. 16 o.c.
24. Built-up girder and beams	20d common (4 0.192) 32 o.c. 3 0.131 nail at 24 o.c. 3 14 gage staple at 24 o.c.	face nail at top and bottom staggered on opposite sides
	2 - 20d common (4 0.192) 3 - 3 0.131 nails 3 - 3 14 gage staples	face nail at ends and at each splice
25. 2 planks	16d common ($3^1/_2$ 0.162)	at each bearing
26. Collar tie to rafter	3 - 10d common (3 0.148) 4 - 3 x 0.131 nails 4 - 3 14 gage staples	face nail
27. Jack rafter to hip	3 - 10d common (3 x 0.148) 4 - 3 0.131 nails 4 - 3 14 gage staples	toenail
	2 - 16d common ($3^1/_2$ 0.162) 3 -3 0.131 nails 3 - 3 14 gage staples	face nail
28. Roof rafter to 2-by ridge beam	2 - 16d common ($3^1/_2$ 0.162) 3 - 3 0.131 nails 3 - 3 14 gage staples	toenail
	2-16d common ($3^1/_2$ 0.162) 3 - 3 0.131 nails 3 - 3 14 gage staples	face nail
29. Joist to band joist	3 - 16d common ($3^1/_2$ 0.162) 4 - 3 0.131 nails 4 - 3 14 gage staples	face nail

(continued)

TABLE 2304.9.1—continued
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
30. Ledger strip	3 - 16d common (3 1/2 0.162) 4 - 3 x 0.131 nails 4 - 3 14 gage staples	face nail
31. Wood structural panels and particleboard[b] Subfloor, roof and wall sheathing (to framing)	1/2 and less: 6d[c,l] 2 3/8 0.113 nail[n] 1 3/4 16 gage[o] 19/32 to 3/4: 8d[d] or 6d[e] 2 3/8 0.113 nail[p] 2 16 gage[p] 7/8 to 1: 8d[c] 1 1/8 to 1 1/4: 10d[d] or 8d[d]	
Single Floor (combination subfloor-underlayment to framing)	3/4 and less: 6d[e] 7/8 to 1: 8d[e] 1 1/8 to 1 1/4: 10d[d] or 8d[e]	
32. Panel siding (to framing)	1/2 or less: 6d[f] 5/8: 8d[f]	
33. Fiberboard sheathing[g]	1/2: No. 11 gage roofing nail[h] 6d common nail (2 0.113) No. 16 gage staple[i] 25/32: No. 11 gage roofing nail[h] 8d common nail (2 1/2 0.131) No. 16 gage staple[i]	
34. Interior paneling	1/4: 4d[j] 3/8: 6d[k]	

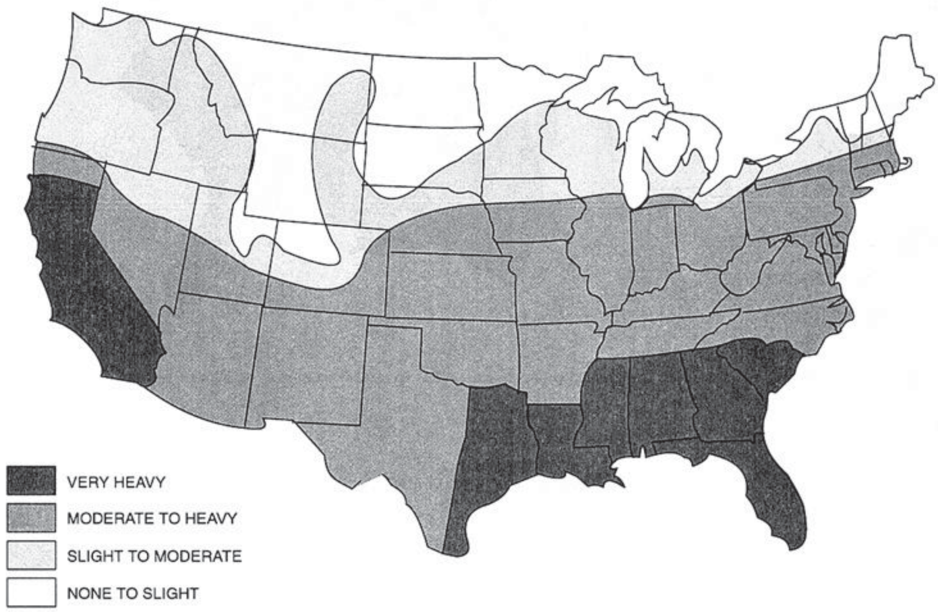
For SI: 1 inch = 25.4 mm.

a. Common or box nails are permitted to be used except where otherwise stated.
b. Nails spaced at 6 inches on center at edges, 12 inches at intermediate supports except 6 inches at supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.
c. Common or deformed shank (6d - 2 0.113 ; 8d - 2 1/2 0.131 ; 10d - 3 0.148).
d. Common (6d - 2 0.113 ; 8d - 2 1/2 0.131 ; 10d - 3 0.148).
e. Deformed shank (6d - 2 0.113 ; 8d - 2 1/2 0.131 ; 10d - 3 0.148).
f. Corrosion-resistant siding (6d - 1 7/8 0.106 ; 8d - 2 3/8 0.128) or casing (6d - 2 0.099 ; 8d - 2 1/2 0.113) nail.
g. Fasteners spaced 3 inches on center at exterior edges and 6 inches on center at intermediate supports, when used as structural sheathing. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications.
h. Corrosion-resistant roofing nails with 7/16-inch-diameter head and 1 1/2-inch length for 1/2-inch sheathing and 1 3/4-inch length for 25/32-inch sheathing.
i. Corrosion-resistant staples with nominal 7/16-inch crown and 1 1/8-inch length for 1/2-inch sheathing and 1 1/2-inch length for 25/32-inch sheathing. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).
j. Casing (1 1/2 0.080) or finish (1 1/2 0.072) nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
k. Panel supports at 24 inches. Casing or finish nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
l. For roof sheathing applications, 8d nails (2 1/2 0.113) are the minimum required for wood structural panels.
m. Staples shall have a minimum crown width of 7/16 inch.
n. For roof sheathing applications, fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.
o. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports for subfloor and wall sheathing and 3 inches on center at edges, 6 inches at intermediate supports for roof sheathing.
p. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.

Termite Protection

Framers in many areas of the country have to be concerned about protection against termites. Pressure preservative-treated wood, naturally termite-resistant wood, or physical barriers can be used to prevent termite damage. The following map shows termite infestation probability by region.

Termite Infestation Probability



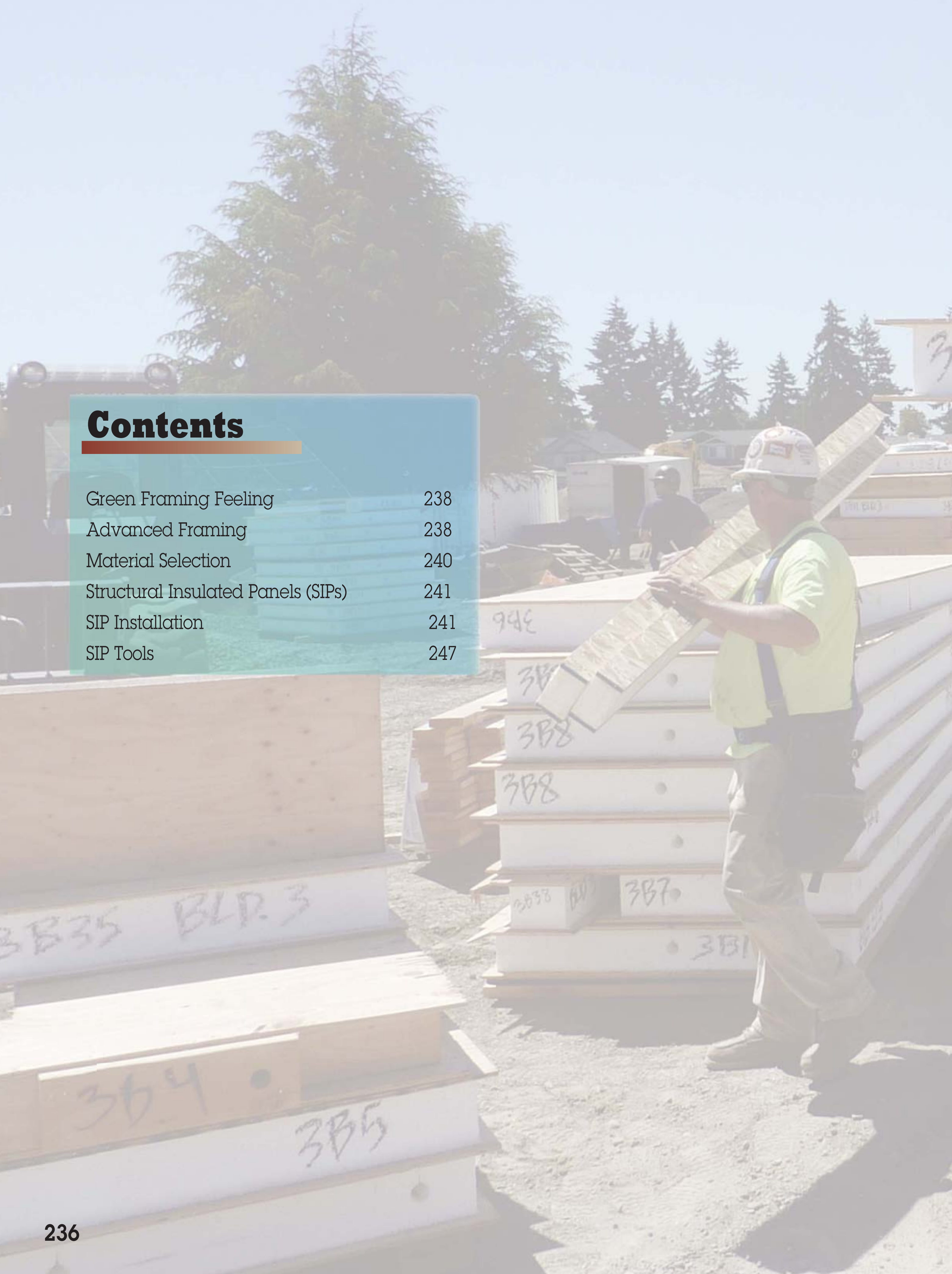
Note: Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.

Source: International Code Council (ICC)

Conclusion

An important part of your job as a lead framer is being aware of the building codes that apply to framing in your part of the country. You should be aware of how to use the code and of any revisions to those codes. Although locating information you need in the code books is often the hardest part of using the codes, the "Framing Index" at the beginning of this chapter should make this easier for you. It's a good feeling to know that you have framed a building the way it's specified according to code.

Chapter Eleven
GREEN FRAMING



Contents

Green Framing Feeling	238
Advanced Framing	238
Material Selection	240
Structural Insulated Panels (SIPs)	241
SIP Installation	241
SIP Tools	247

Chapter Eleven

GREEN FRAMING

Green Framing is as much an attitude as it is an act of doing certain forms of framing. There are some framing designs and materials that are considered "green" but to be a green framer it takes a belief that you want to be a part of the global effort to reduce our effects on the ecosystem. In this chapter I will show you how the green movement is affecting the materials we use and in some cases the way we frame. I will also give you a basic understanding of the construction industry efforts to become green. In additions to this, I will discuss some behaviors that if you so choose will make you a part of the movement.

A little history is probably a good place to start. It's hard to say when the first discussions about how the human race is effecting the environment occurred and what we can do to our building practices to prevent ill effects, but Optimum Value Engineering, which has become known as *Advanced Framing*, was one of the first applications of green building. Advanced framing is an effort to conserve energy by altering framing techniques. It was soon realized, however that an overall building effort was needed to direct the construction industry in order to achieve the best effects. In 2000 the United States Green Building Council (USGBC) was formed and they created LEED (Leadership in Energy and Environmental Design) which is a construction and design industry joint effort to define and certify construction using green methods. The LEED program creates a tool for measuring the green building effectiveness by assigning credits in six areas: Sustainable Sites; Water Efficiency; Energy and Atmosphere; Materials and Resources; Indoor Environmental Quality; and Innovation and Design Process. Credits are totaled for individual jobs allowing for certification at different levels including, Certified, Silver, Gold, or Platinum. These certifications can be used in marketing programs.

LEED is an excellent construction- and design-oriented program to promote green building, however, it is a new and separate organization requiring its own fees and training. In 2008, the International Code Council (ICC) and the National Association of Home Builders (NAHB) came out with the National Green Building Standard ICC700-2008. Designed to guide the residential construction industry in green building, this standard was similar to the LEED system. It provided a rating system of environmental categories similar to LEED and performance levels of Bronze, Silver, Gold or Emerald. The ICC700-2008 is a good guide, but is hard to regulate.

In 2010, the ICC published the International Green Construction Code (IGCC), the first ever compilation of international green building codes and standards. USGBC along with other agencies worked to help develop the IGCC. USCBC's LEED program set the format for guiding the design and construction industry in green building; however, it is a voluntary program and does not have jurisdictional enforcement capabilities.

The IGCC has similar topics for its five main content chapters, however, once the IGCC is

accepted by a jurisdiction it becomes law for that jurisdiction. Unique to the IGCC for the other building codes is a section of regulations that relates to individual jurisdictions, so that each jurisdiction has to select from a group of regulations as to which ones they will require. There is an elective section where jurisdiction is required to determine the amount of a list of elective requirements that must be met.

It's all a bit confusing and most of it does not apply directly to framing, however some items will. For example, Chapter 5 of the IGCC, "Material Resource Conservation and Efficiency," notes a requirement to develop a construction material and waste management plan that requires not less than 50 percent of non-hazardous construction waste to be diverted from landfills.

Green building is wide spread in the construction process, however green framing is limited. Four parts of green framing that I will discuss are as follows:

1. Greening Framing Feeling
2. Advanced Framing
3. Material Selection
4. Structural Insulated Panels (SIPs)

Green Framing Feeling

Green framing feeling sounds a little subjective, but that's because it has to be. For example, you are out on the job site framing, and the questions is whether to throw a small cut off of 2 × 6 into the trash or try to find a place to use it in your building process. Your decision is not only based on the cost of that piece of cut-off, but also the ease of just trashing it and the effect on the environment by using a new piece. Not an easy call to make, but you will have to make decisions like that all the time. If you choose the extra effort to conserve material, you will get a good green framing feeling.

Advanced Framing

A more tangible aspect of green framing is advanced framing. Based on the concept that wood is not as good an insulator as insulation, reduce the amount of wood in the exterior skin of a building and you will save energy and conserve building resources.

There are numerous ways to reduce the amount of wood in a building, but reducing the wood will reduce the building's strength. There are ways, however, to reduce the amount of wood that either don't affect the strength or still create strength enough to meet code requirements.

Some of the most common ways to reduce the amount of wood are the following:

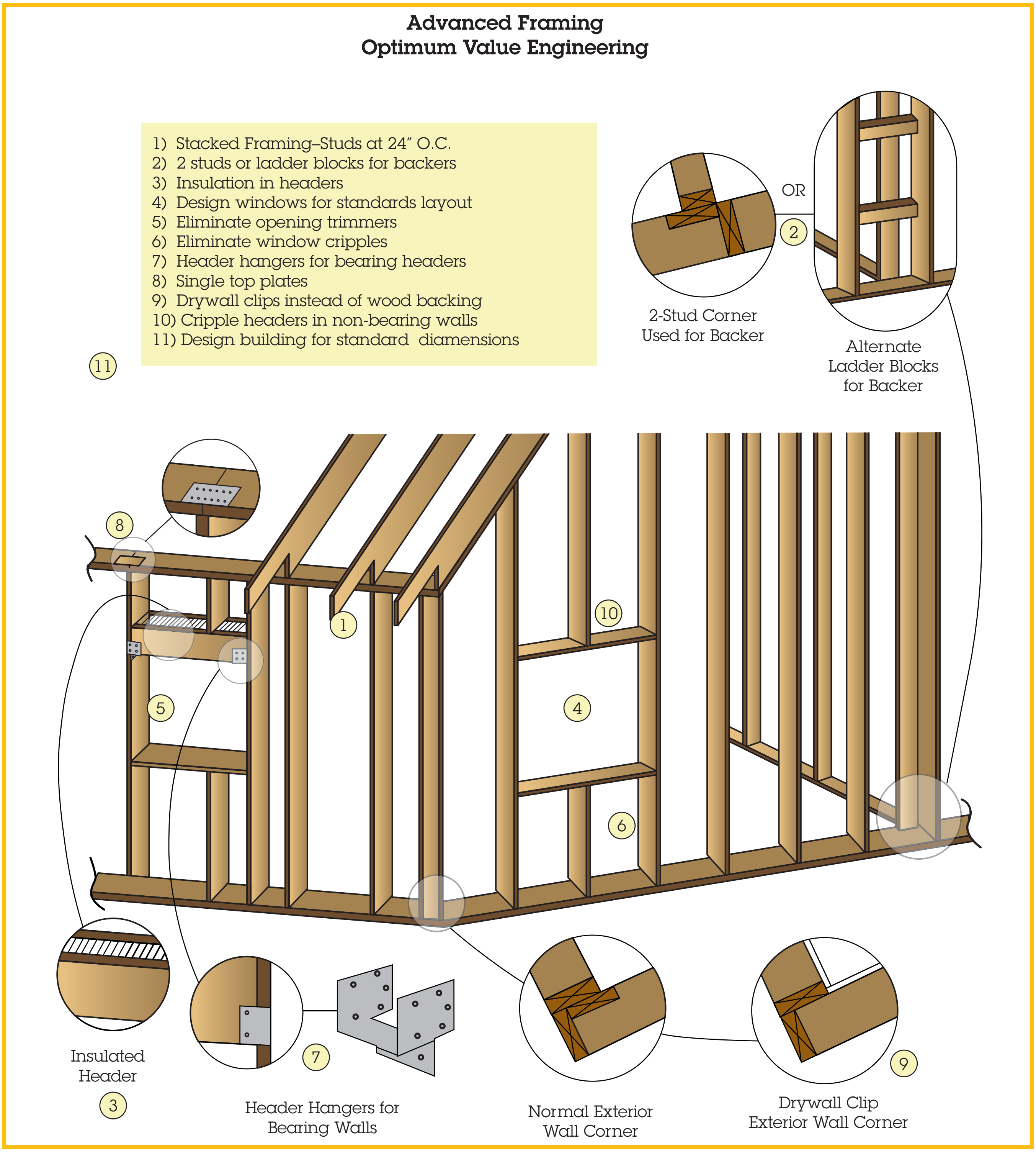
1. Changing the stud layout from 16" O. C. to 24" O.C.
2. Changing common 3 stud backer to 2 × 4/2 × 6 L backer or ladder blocking
3. Using drywall clips instead of wood backing
4. Using insulation in headers instead of wood fillers
5. Using a cripple header instead of solid headers for non-bearing walls
6. Using single top plates
7. Eliminating trimmers where not necessary
8. Eliminating window cripples
9. Adjusting layout or door and window locations so layout aligns with stud-trimmers
10. Changing the exterior wall from 2 × 4 studs to 2 × 6 walls.
11. Using standard lengths during building so that standard material can be used with less waste.

The "Advanced Framing" illustration shows these 11 techniques. They may already be

integrated into your plans or you can integrate them on your own. If they are not already on your plans, make sure they do not conflict with the plans or that you receive the engineer's approval.

Advanced framing was originally developed to assist builders in using methods that would save energy in houses. Because energy conservation is a major component of green building it is now a part of green framing.

Advanced Framing



Material Selection

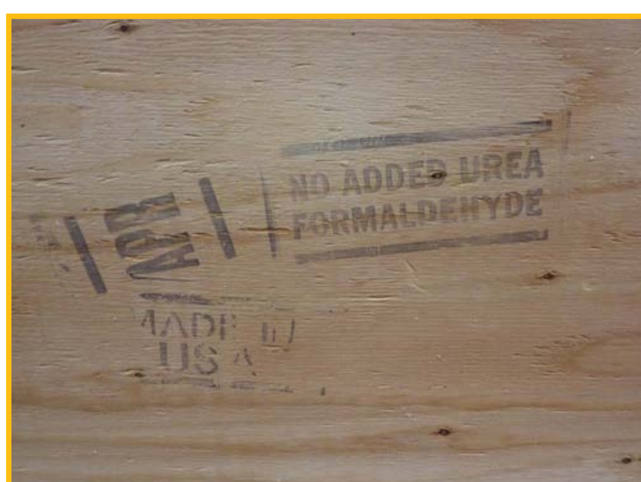
Material selection is a concern for green framing. The following are six ways in which material selection is considered green.

1. **Use of Forest Stewardship Council (FSC) and Sustainable Forest Initiative (SFI) certified lumber.** This is lumber that is harvested following environmentally friendly guidelines for sustainable practices. This lumber is tracked through the chain of custody from the forest to the end user. It is labeled for identification.
2. **Use of salvaged or reused material.** reusing lumber minimizes the need for new lumber.
3. **Use of regional material.** This is material that is harvested typically within 500 miles of the end use. The value gained is from the transportation energy savings.
4. **Use of rapidly renewable material.** This is usually considered material that has a 10 year or less growth cycle.
5. **Use of composite panels that contain no added urea formaldehyde resins.** Plywood and Oriented-Strand Board (OSB) commonly use adhesives containing urea formaldehyde which is a known carcinogen. No-Added-Urea Formaldehyde composite panels are available.
6. **Minimized use of volatile organic compounds (VOCs).** VOCs release toxins. Products such as subfloor adhesives will list the amount of VOCs that they contain. A tube of subfloor adhesive labeled “VOC Compliant” (see “VOC Compliant Subfloor Adhesive” photo) has VOC less water, less

Forest Stewardship Council Label

Sustainable Forestry Initiative Label

Panel Label “No Added Urea Formaldehyde”



VOC Compliant Subfloor Adhesive

exempt solvent: <196g/l and <10.6% wt/wt. This makes it compliant with California ARB, which are among the strictest standards.

Structural Insulated Panels (SIPs)

SIPs are a structural sandwich panel made of a foam plastic insulation core bonded between two structural facings usually made of oriented-strand board (OSB). SIPs are most commonly used for walls and roofs, but can also be used for floors and foundation systems. SIPs are considered green because of their expected energy savings. It is also expected there will be conservation of material because SIPs are made in shops.

If you are framing with SIPs you will not be using the standard framing steps presented earlier in this book. Basically, you will be putting together panels of floors, walls and roofs with splines, headers, top and bottom plates, sealant, SIP tape, nails and SIP screws. Section R613 *Structural Insulated Panel Wall* construction of the International Residential Code gives prescriptive requirements for using SIPs for wall construction, but since each SIP manufacturer varies in their SIP construction it is best to follow the directions and plans the manufacturers provide.

SIP Installation

The concept of structural insulated panels was started in 1935, but it wasn't until 1990 that they were used enough for the Structural Insulated Panel Association to be created to organize the SIP industry. SIPs from different manufacturers are similar and their installation methods are common. SIP systems for floors, walls, and roofs can be used together, but are commonly used independently with standard framing for the other systems. The following installation steps give general directions for installing SIP walls. Walls are the most common use of SIPs and the installation of roofs and floors is similar. These steps can help organize the process.

1. **Organize your SIPs.** The most labor involved in erecting SIPs is moving of the panels. It is important that when the panels arrive on site that they are organized properly. If the SIPs are being set with a boom from the delivery truck then you need to coordinate with the SIP's manufacturer so that the panels are loaded in the sequence that you plan to use them. If the panels are unloaded from the delivery truck then you want to have your erection sequence developed and handy so you can unload and store the panels in a location that will make the first ones you need the easiest to access (see "SIPs Organized" photo).

SIPs Organized, Transit for Leveling, Sill Plate and Bottom Plate Attached

2. **Check the foundation or platform for level, square and dimensions**. When starting out it is important the walls have a level surface to sit on and the building is square. Where necessary, shim your bottom plates or use a power plane to make sure they are level, and when you are chalking lines for setting your bottom plates, adjust the lines so they are square and dimensioned per plan.
3. **Install sill plate**. If you are using sill insulation you will need to apply it before installing the sill plate. It is usually a piece of foam about 1/8" thick and the width of your sill plate. To install it just hold it in position over the anchor bolts and press down to punch a hole in the insulation (see "Sill Insulation" photo).

   The sill plate will probably need to be ripped to the dimension of the full width of the panel. For installation follow the same process used in standard wall framing. Mark and drill for your anchor bolts using your chalk lines for location and then align with the anchor bolts and drop into place.
4. **Install bottom plate**. The bottom plate needs to be the same width as the foam area of the panel, commonly 5-1/2". It will be bolted to the center of the sill plate so that the faces of the SIP will fit on either side. Both sides of the face will be nailed into the bottom plate. Place a bead of seal between the sill plate and the bottom plate. Secure the bottom plate and sill plate in place with a washer and nut on top of the bottom plate.

Sill Insulation

5. **Install splines where needed**. Sometimes the SIPs come with the splines attached on one side. If this is not the case you will need to insert the spline into the panel before you erect it. Check the panel to make sure that the area to receive the spline is free from debris, then apply continuous seal on the surfaces, insert the spline, and nail it in place (see "Attaching Spline" photo). Three common types of splines are shown in the *SIP Assembly* illustration later in this chapter.
6. **Check panel connection areas and electric chases**. Before standing the panel up, check

the one it will be connecting to. If the panel ends with an opening or a corner, check the location and trim if necessary. Circular saws and chain saws are commonly used for trimming panels and foam scoops can be used on the foam.

Where factory-supplied electrical chases are in the SIPs you will need to make sure that any splines you install have corresponding holes to allow for running electric wire. Mark and drill the splines if necessary before you install them.

7. **Seal panel to be installed**. Because SIPs are meant to be energy efficient it is particularly important to continuously seal all adjoining surfaces (see "Sealing" photo). The spline details in the *SIP Details* illustration later in this chapter show the locations of the seal.
8. **Set panel in place**. Tip the panel into place hinging on the far corner of the bottom of the wall (see "Installing SIP Panel" photo).
9. **Plumb and brace panel.** After the panel is standing check for proper placement, plumb both directions, and then nail in place and brace if needed. Sledge hammers, crow bars, long bar clamps, and come-alongs can be used to pull the panels together when needed. Allow a 1/8" space between panel faces.

Attaching Spline

10. **Nail and screw panel.** Panel screws come with the panels and you need to follow the manufacturer's suggested location for their installation. Also follow the manufacturer's instructions for size and

Sealing

Installing SIP Panel

spacing of the nailing. You will be using your standard framing nails. See the SIP Details illustration later in this chapter.

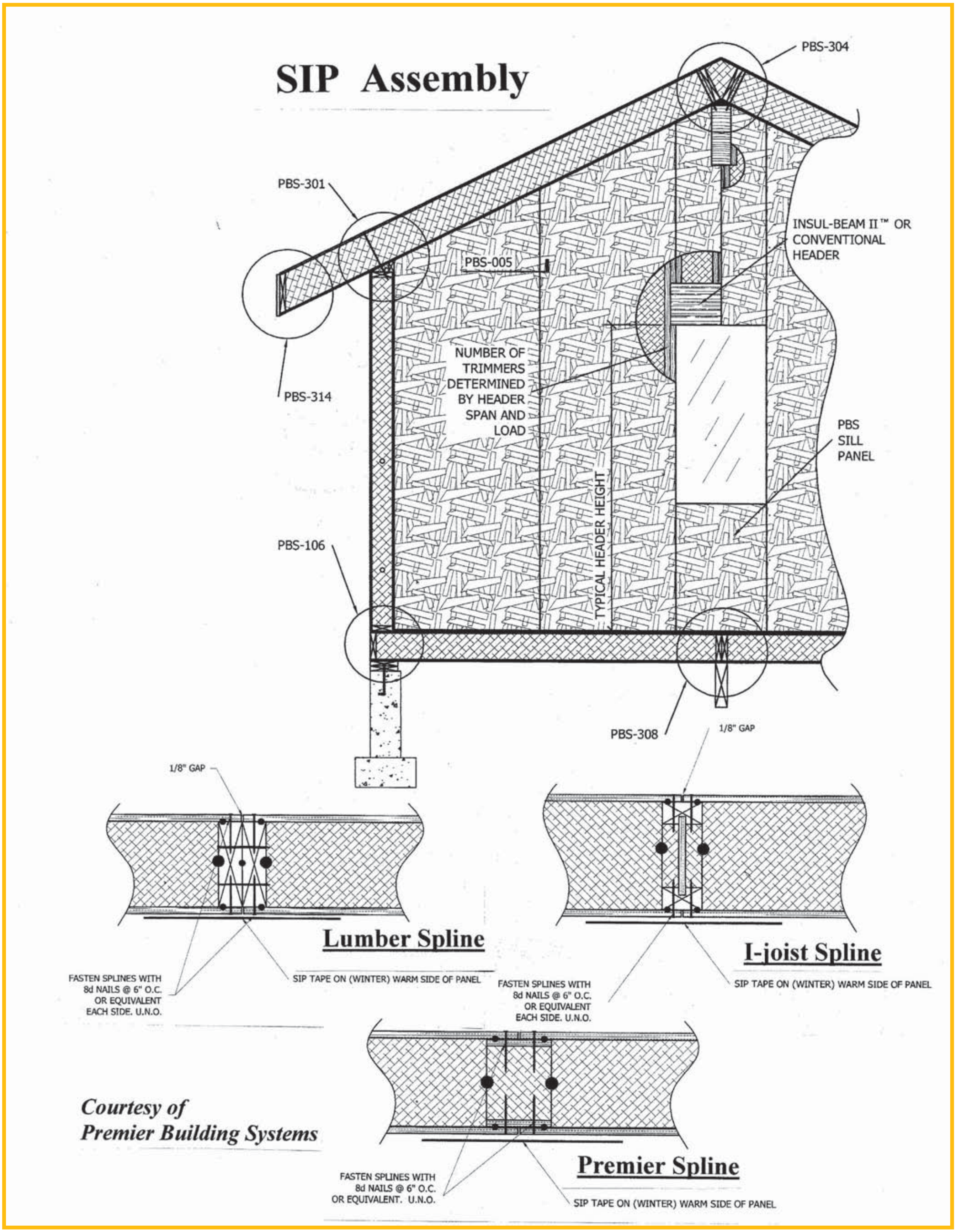
11. **Install top and double plates**. Top plates and double plates are installed to provide overlapping at intersections, corners, and splines. The top plate needs to be made of 2x wood, recessed into the panel, and nailed between the faces. The double plate needs to overlap the top plate a minimum of 2 feet and be the width of the SIP including the faces.
12. **Apply SIP tape**. As a last step, apply the SIP tape to the inside seams of all SIPs (see "Applying SIP Tape" photo).

The following *SIP Assembly SIP Details* illustrations are from a SIP manufacturer and give you an idea of what you can expect for instructions from SIP manufacturers.

See "SIP Tools" photos for examples of tools that are commonly used for SIP installation, but not often used in standard framing. Standard framing tools are also used in installing SIPs.

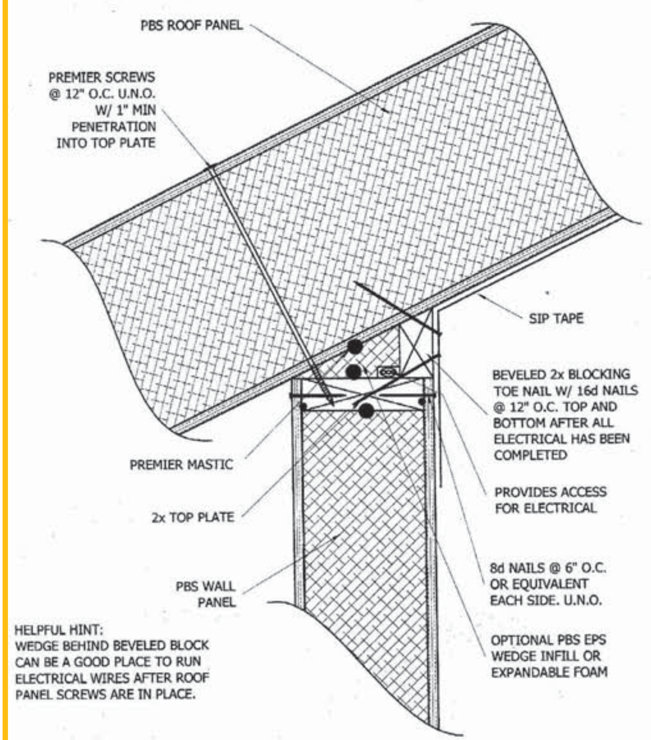
Most important to SIP installations is organization. If you want to have a successful and productive job, do your homework and make sure you have all the tools you will need, your foundation is level and square, and you have a good understanding of where each and every piece of the puzzle will fit.

Applying SIP Tape

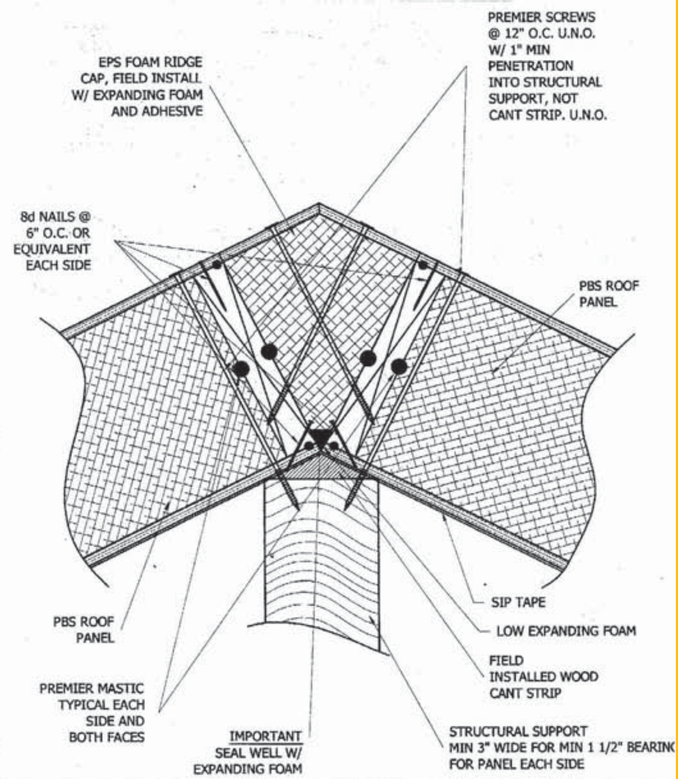

SIP Assembly
PBS-304
PBS-301
PBS-005
INSUL-BEAM II™ OR
CONVENTIONAL
HEADER
PBS-314
NUMBER OF
TRIMMERS
DETERMINED
BY HEADER
SPAN AND
LOAD
PBS
SILL
PANEL
PBS-106
TYPICAL HEADER HEIGHT
PBS-308
1/8" GAP
1/8" GAP
Lumber Spline
I-joist Spline
FASTEN SPLINES WITH
8d NAILS @ 6" O.C.
OR EQUIVALENT
EACH SIDE. U.N.O.
SIP TAPE ON (WINTER) WARM SIDE OF PANEL
FASTEN SPLINES WITH
8d NAILS @ 6" O.C.
OR EQUIVALENT
EACH SIDE. U.N.O.
SIP TAPE ON (WINTER) WARM SIDE OF PANEL
Courtesy of
Premier Building Systems
Premier Spline
FASTEN SPLINES WITH
8d NAILS @ 6" O.C.
OR EQUIVALENT. U.N.O.
SIP TAPE ON (WINTER) WARM SIDE OF PANEL

SIP Details

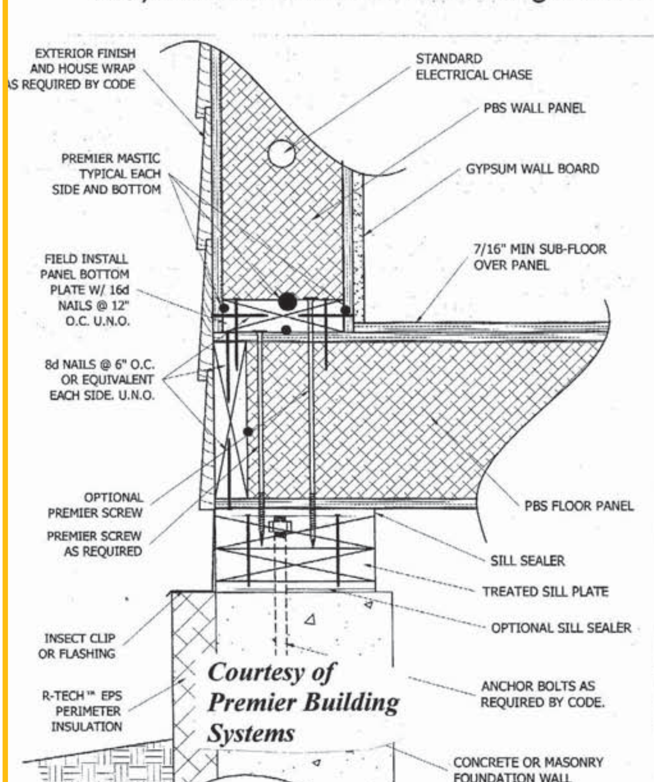
Roof Details: Beveled Block Wall/Roof 1 PBS-301



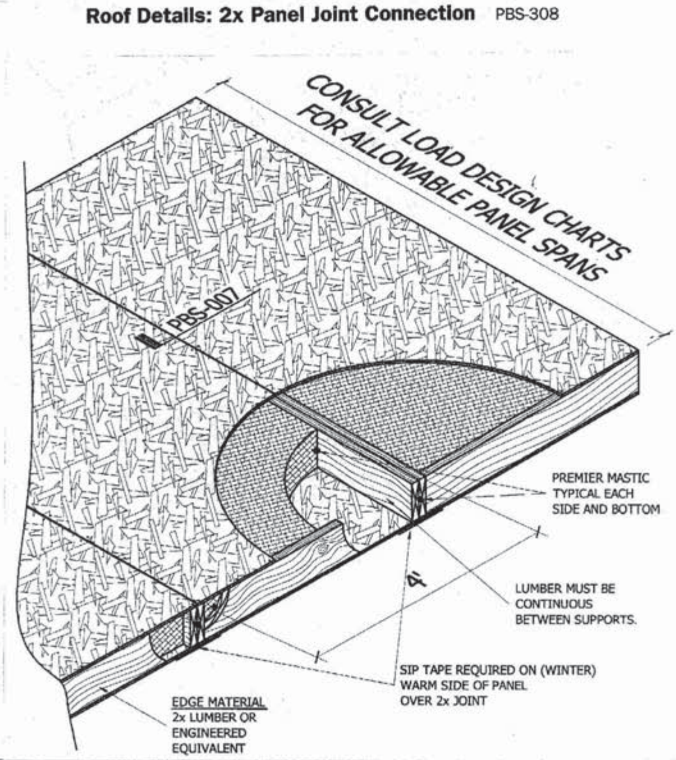
Roof Details: Ridge Cap Detail PBS-304



Floor/Foundation Details: Foundation Framing 1 PBS-106



Roof Details: 2x Panel Joint Connection PBS-308



SIP Tools

12" Blade Beam Cutter

Foam Scoop

Lifting Eyebolts and Plates

Foam Gun

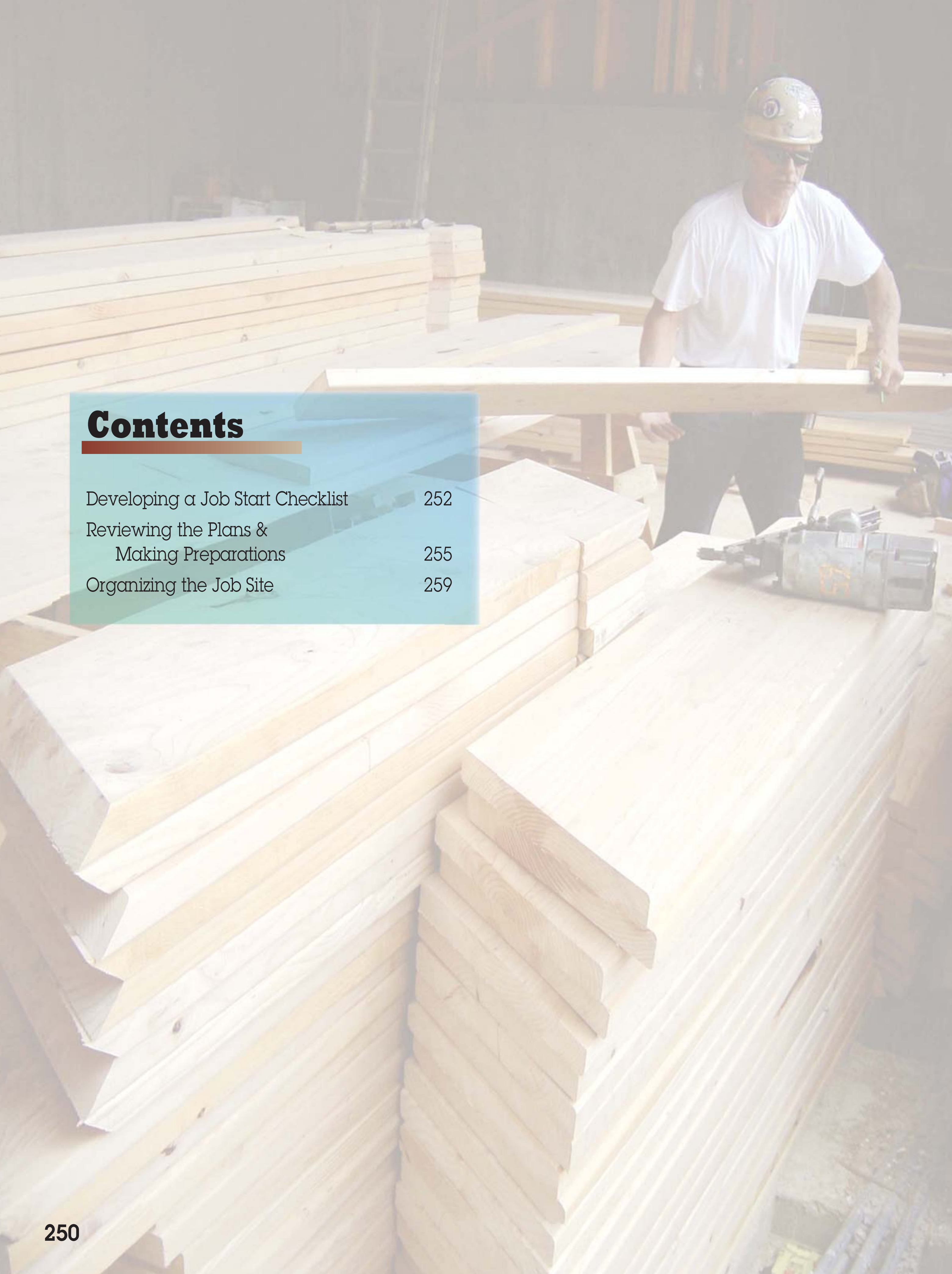
Ratchet Straps

Power Planer

Come-along

Bar Clamp

Chapter Twelve
PREPARING FOR A JOB



Contents

Developing a Job Start Checklist 252

Reviewing the Plans & Making Preparations 255

Organizing the Job Site 259

Chapter Twelve

PREPARING FOR A JOB

The best way to make any project start smoothly is to adequately prepare for the job. This means spending time looking over the plans, and organizing information, and talking with whoever is overseeing the job before you start working on the job site.

Often, the lead framer does this preparation the night or morning before a job starts. You'll find that the work will flow more smoothly if you begin preparation earlier and do it right.

If you're a carpenter working for a framing contractor or a general contractor, many of the preparation tasks listed in this chapter will be done for you. If, on the other hand, you are the lead framer, framing contractor, and home builder all in one, then it's up to you to get these done.

In this chapter, the word *superintendent* refers to the person on the job site who answers any questions related to the building. This person's actual title might also be *builder*, *owner*, or *framing contractor*. Although this book is about house framing, we use the word *building*, since the preparation is very similar whether it is a house, multi-family housing, a commercial building, or any structure where wood framing is used.

If you are preparing to start the job with the foundation slab in place, you will need to perform these four tasks:

1. Develop a job start checklist.
2. Review the plans and make preparations.
3. Organize the job site.
4. Conduct the pre-start job site review meeting.

Developing a Job Start Checklist

Using a job start checklist is a good way to prepare. Your framing will be organized and will move at a steady pace if all the items on this list are addressed. You can fill out the checklist in a pre-start job site review meeting. While the pre-start visit is not absolutely required, it is a very productive part of the preparation.

Following is a blank Job Start Checklist that can be used at the job site review meeting. Along with the checklist is an explanation of some points to consider as you check off each item. Although the items may vary from job to job, most items on this list are common to all jobs. You should also add your own items to this list.

Job Start Checklist—Explanation

Consider as you check off the job start items.

1. **Power Source**
   - Will you need more than one power source? Bigger jobs sometimes require more than one source.
   - What length of extension cords will you need for power tools? A cord that's too long can burn out your tools.
   - Will you need a heavy lead cord?
   - Is there enough voltage for your tools? A compressor, for example, may require 220 volts.

Job Start Checklist

- ☐ Power Source ______
- ☐ Backfill ______
- ☐ Lumber Drop Location ______
- ☐ Material List ______
- ☐ Anchor Nuts and Washers ______
- ☐ Standard Framing Dimensions List ______
- ☐ Plans—Two copies ______
- ☐ Framing Hardware ______
- ☐ Subfloor Glue ______
- ☐ Mudsill Insulation ______
- ☐ Hold-downs, Tie-downs, Anchoring Systems ______
- ☐ Truss Plans and Delivery Schedule ______
- ☐ Steel Plans and Delivery Schedule ______
- ☐ Reference Point for Finish Floor ______
- ☐ Reference Point for Wall Dimensions ______
- ☐ Location of Truck on the Job Site ______

2. **Backfill**
    - Backfill all possible areas before you start. The more backfill completed, the easier it will be to perform your work.
3. **Lumber Drop Location**
    - Ask for lumber to be dropped as close as possible to the building, and in a central location. If a forklift will be available, you can have the lumber dropped in a more out-of-the-way location, as long as it's easily accessible.
    - Often the lumber you need first is on the bottom of the lumber load when it is dropped. Sometimes you can request that the lumber company load the lumber in the order you will use it.
4. **Material List**
    - Be sure you have a copy of the material takeoff list. This list will help you figure out which size, length, and grade of lumber will be used for which part of the building. It is a good check, and helps prevent mistakes.
5. **Anchor Nuts and Washers**
    - The anchor nuts are generally delivered with the anchor bolts used by the foundation crew. Ask the superintendent to have the nuts located before you arrive on site, since trying to find them can be difficult.
6. **Standard Framing Dimensions List**
    - Go over the list (shown later in this chapter) with the superintendent if applicable. He/she may need to check with the architect, or door or window manufacturer, in order to verify rough openings.
7. **Plans: Two copies**
    - Be sure you have two copies of the plans. You will need one set for the job site. The second set can be used by others, such as the framing contractor, by yourself off site, or by the layout framer on bigger jobs.
8. **Framing Hardware**
    - If you purchase the framing hardware yourself, you can have good control of quantities and delivery. If you don't purchase it, request a hardware purchase list, which will help you identify quantities and type of hardware. It is common for the architect to specify a piece of hardware with a specific identifying number on it, then have the superintendent purchase an equivalent piece of hardware with a different identifying number. It helps to carry a hardware manufacturer's catalog with you for identification purposes. The Simpson Strong-Tie catalogs are most often referenced on plans.
9. **Subfloor Glue**
    - Is subfloor glue required? It may not be called out on the plans or specifications, but sometimes superintendents require it.
10. **Mudsill Insulation**
    - Determine whether mudsill insulation is necessary. Again, it may not be identified on the plans or specifications, but the job superintendent may intend to use it.

11. **Hold-downs, Tie-downs, Anchoring System**
    - It is best to install the hold-down studs when the wall is built, and it is easiest to drill the holes for the hold-down bolts before the hold-down studs are nailed into the wall.
    - Have at least one hold-down of each size on the job site when you start. Because the hold-down sizes vary, it's good to have different sizes available so you can determine stud locations and bolt hole sizes and location. If you do not have the hold-downs, you can use a hardware catalog to determine hole sizes, locations, and stud locations.
12. **Truss Plans and Delivery Schedule**
    - Many buildings have truss plans in addition to the plans provided by the architect. Because you want to line up the studs, floor joists, and roof trusses where possible, it is important to know where the truss manufacturer started the layout. You should use the truss layout and align the studs and floor joists. Truss plans typically call out where the layout starts.
    - Often the truss plans are not drawn until shortly before they are needed. It is best to request the plans early so that they will be available when you need them.
    - Check on the delivery date. Depending on the economy and the local truss manufacturers, the lead time for trusses can vary from days to weeks. You don't want to get to the roof and have to stop because the trusses aren't yet built.
13. **Steel Plans and Delivery Schedule**
    - Typically if you have steel on the job, it should be in place before the wood framing is started. Check to see when it will be ready.
14. **Reference Point for Finish Floor**
    - When you check the floor for level, it helps to have the benchmark used for the concrete work. If you don't have the benchmark, then you have to take a number of different readings to come up with an average before you can determine whether the concrete work is within tolerance. Sometimes the superintendent will be able to give you the benchmark.
15. **Reference Points for Wall Dimensions**
    - Having the reference points will save you time in determining where the lines are actually supposed to be. Since the concrete work is seldom exactly where it is supposed to be, you will have to decide by how much the concrete is off and the best way to compensate for it without doing extra work or compromising the building.
    - If you don't have reference points to work with, you will have to spend extra time taking measurements to determine where the mistakes are located in the concrete.
16. **Location of Job Site Truck**
    - Be sure to locate your truck, trailer, or storage container close to the job site. Planning ahead with the superintendent can often open up a location that later could be occupied by other trades, material, or supplies.

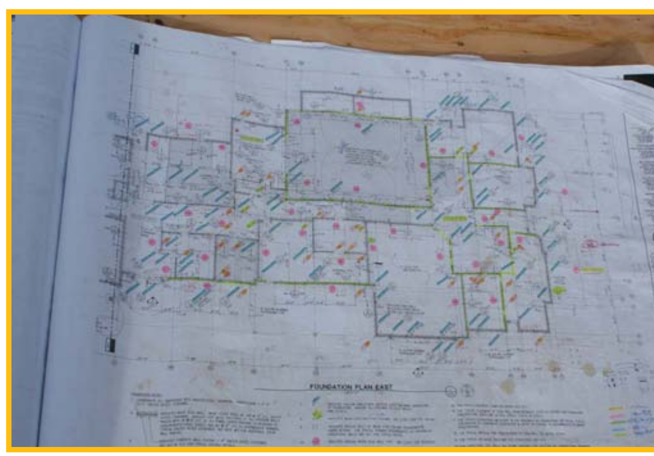
Reviewing the Plans & Making Preparations

Plan review will save you time and energy, and make your work more productive. If you are framing a house with a plan you have used before, then you have already done the review. But if you are framing a new house design or, particularly, a multi-unit or commercial building, then it becomes very important to review the plans. Here are some of the most common ways of reviewing plans:

1. Study the plans. Sit down with the plans and figure out how the building is put together. Read the specifications. Most often they are standard and you can skim through them, but make sure to note anything that is new or different. Know enough about the new material so that you can understand the architect's explanations. If you can't figure it out, ask the framing contractor, superintendent, or architect about that particular element. If you are on a large job where the specifications come bound by themselves, you should know that they are probably organized under the Construction Specification Institute's (CSI) MasterFormat. Under this system, rough carpentry is listed in Division 6 as 06 10 00. This section contains the basic specification information about framing this job.

2. Make a list of questions. While you are studying the plans, have a pad of paper and pencil handy so you can write down any questions. Go over these questions with the superintendent at the pre-start job site review meeting. Often, getting a question answered or a problem solved before the job begins saves an interruption in the framing. Even a little thing like the architect missing a dimension on the plans can cause a delay. If the superintendent okays scaling the missing dimensions, there won't be a problem; but if you need verification on missing dimensions, it's best to get them before you begin.

3. Highlight the plans. It's a big help to highlight easy-to-miss items on your plans. Use the same color highlights on all jobs so that it becomes easy to identify items for you and your crew. An example would be:
   Orange—Hold-downs
   Pink—Shear walls
   Green—Glu-lam beams
   Blue—Steel
   Yellow—Special items



Highlighting the plans

4. Establish framing dimensions. Most rough openings are standardized, but because of exceptions and differences in floor covering, it's important to go over the rough openings before the job begins. The information sheets that follow can be used for reviewing these dimensions with the superintendent.

There is a sheet for $88\frac{5}{8}$" studs and one for $92\frac{5}{8}$" studs. These can be adjusted for different size studs. Go over each item with the superintendent or whoever is in charge of the job. Ask him/her to review the sheet and indicate that you will be using the rough-opening dimensions listed unless you are instructed differently. Note that $88\frac{5}{8}$" studs are standard because with a 4 × 8 header, they leave a standard 82½" door opening. Note, too, that $92\frac{5}{8}$" studs work with a 4 × 12 header. (See "Standard Framing Dimensions" sheets.)

Framer-Friendly Tips

Door and window manufacturers can provide specification sheets that show RO sizes.

Taping the plans

These sheets apply to residential framing. Commercial framing is not so standardized. Note that the use of hollow metal (H.M.) door and window frames is common in commercial framing. The frames are usually 2" in width. Rough openings (R.O.) for H.M. frames would typically be 2" for the frame plus ¼" installation space. As an example, a 3'-0" door would have an R.O. width of 3'-4½", which is made up of 3'-0" for the door opening, 4" for the frames on each side, and ½" for the ¼" installation space on each side. The R.O. height would be 7'-2¼", which would be made up of the 7'-0" for the door opening, 2" for the frame, and ¼" for installation space.

5. Tape the plans. Plan deterioration can be a problem, particularly at the end of a job. Use the same set of plans when possible so they include your highlighting and any changes that you have marked. When possible, request water-resistant print paper for the plans. If you're in a rainy area or season, this will keep the lines from running. Plastic covers are made to cover plans, but they can make it difficult to turn the pages. Clear plastic adhesive covering can be used, but then you can't write on the plans to note changes. A good system is to use clear plastic wrapping tape to tape the edges of the plans. This treatment usually provides the stability to make it through the job while still allowing for notes written on the plans.

Standard Framing Dimensions $88^5/8$" Studs

		Header Size	Trimmer Size **
Stud height......................	88⁵/₈″		
Wall height......................	93¹/₈″		
R.O. windows..................	Width—nominal		
	Height—nominal	4 x 8	81¹/₈″
		4 x 10	79¹/₈″
R.O. exterior doors...........	Width—nominal + 2½″		
	Height—82⁵/₈″	4 x 8	81¹/₈″
	Height—82¹/₈″	4 x 10	80⁵/₈″ cut T.P.***
R.O. sliding glass doors....	Width—nominal		
	Height—6′-10″ door 82¹/₈″	4 x 8	81¹/₈″/ ½″ furr*
	82¹/₈″	4 x 10	80⁵/₈″ cut T.P.
	Height—6′-8″ door 80¹/₈″	4 x 8	81¹/₈″/ 2½″ furr
	80¹/₈″	4 x 10	79¹/₈ / ½″ furr
R.O. interior doors............	Width—nominal + 2″		
(nonbearing)	Height—82⁵/₈″		81¹/₈″
R.O. bifold doors..............	Width —nominal + 1¼″ for ½″ drywall —nominal + 1½″ for ⁵/₈″ drywall		
	Height — 82⁵/₈ ‶		81¹/₈″
R.O. bypass doors............	Width—nominal		
	Height—82⁵/₈″		81¹/₈″
R.O. pocket doors............	Width — 2 x nominal + 1″		
	Height—84½″		83″
Bathtubs..........................	Width—nominal + ¼″		
Tub fireblocks.................	14½″ from finish floor to bottom of block		
Medicine cabinet...........	R.O. 14½″ × 24″		
blocks	Height—48″ from finish floor to bottom of R.O. 3″ minimum away from wall corner		

These dimensions should be checked with the job site superintendent before beginning each job.

* Furr = furring under header after header is in place.

** Trimmer heights will increase by 1½" if lightweight concrete is used or ¾" if gypcrete is used.

*** Cut T.P. —Cut the top plate out and leave the double plate.

R.O. (rough opening) – Any opening framed by the framing members.

Standard Framing Dimensions $92^{5}/8$" Studs

		Header Size	Trimmer Size **
Stud height......................	92⅝″		
Wall height......................	97⅛″		
R.O. windows..................	Width—nominal		
	Height—nominal	4 x 8	85⅛″
		4 x 10	83⅛″
R.O. exterior doors...........	Width—nominal + 2½″		
	Height—82⅝″	4 x 8	85⅛″/4″ furr*
	Height—82⅝″	4 x 10	83⅛″/2″ furr cut T.P.***
R.O. sliding glass doors....	Width—nominal		
	Height—6′-10″ door 82⅛″	4 x 8	85⅛″/ 4½″ furr
	82⅛″	4 x 10	83⅛″ /2½″ furr
	Height—6′-8″ door 80⅛″	4 x 8	85⅛″/ 6½″ furr
	80⅛″	4 x 10	83⅛″/ 4½″ furr
R.O. interior doors............	Width—nominal + 2″		
(nonbearing)	Height—82⅝″		81⅛″
R.O. bifold doors..............	Width —nominal + 1¼″ for ½″ drywall —nominal + 1½″ for ⅝″ drywall		
	Height — 82⅝ ʺ		81⅛″
R.O. bypass doors............	Width—nominal		
	Height—82⅝″		81⅛″
R.O. pocket doors............	Width — 2 x nominal + 1″		
	Height—84½″		83″
Bathtubs..........................	Width—nominal + ¼″		
Tub fireblocks.................	14½″ from finish floor to bottom of block		
Medicine cabinet............	R.O. 14½″ × 24″		
blocks	Height—48″ from finish floor to bottom of R.O. 3″ minimum away from wall corner		

These dimensions should be checked with the job site superintendent before beginning each job.

* Furr = furring under header after header is in place.

** Trimmer heights will increase by 1½" if lightweight concrete is used or ¾" if gypcrete is used.

R.O. (rough opening) – Any opening framed by the framing members.

Organizing the Job Site

After the plan review, you need to organize the job site. Figure out what your initial manpower needs and schedule are, and what tools you'll need for the job. The first day on the job site is usually a challenge.

1. **Manpower needs.** Typically, on the first day, your crew is ready to go to work and will be looking to you for instruction. At the same time you may not be sure if the concrete is level or the right size. Meanwhile, the superintendent may be on his way over with his list of things you need to take care of. If you have too many framers, everyone might be standing around until you get the job organized. If your schedule allows, start with just a two-man crew to check the foundation or slab for level and size and to get some lines chalked and some detailing done.
2. **Manpower tasks.** Knowing which jobs you want each framer to do before you get there always helps. Also, keep a couple of back-up tasks (such as cleaning out the truck or fixing tools) in mind in case something prevents you from starting right away. First-day jobs might include:
   - Cleaning the slab or foundation
   - Checking concrete dimensions
   - Checking level of concrete
   - Cutting makeup and headers
   - Nailing makeup and headers
   - Chalking lines
   - Setting up chop saw (radial arm or similar)
   - Building plan shack
   - Detailing plates
3. **Tools.** Not having the right tools can be like trying to cut the Thanksgiving turkey with a table knife. The tool list that follows will help you determine what you need. For example, you can look at the plans to find out what size bolts are being used so you can be sure to have the appropriate drill bits and impact sockets ready.

   It's easy to show up the first day without some of the necessary tools. Also, you might use different tools at the beginning of a job and at the end of a job. Highlighting the tools you need on the Tool List before the job starts will help you prepare and save time.

   Note that the "Location" column on the Tool List at the end of this section refers to the location where the tools are kept. (See legend on tool list.) The locations listed can be adjusted to your own situation.
4. **Plans.** Any time you can devote to the plans before you start the job is probably well spent. Two things are particularly important for getting started. First, decide where you are going to pull your layout from (see Chapter 7), and second, decide which lines you are going to set for reference (see "Getting Started" in Chapter 13).

   Looking at plans on the job site can be like trying to read a map while on a motorcycle: there is always the sunshine, wind, or rain. On the job site, you'll be juggling a number of things. Your crew will be asking you what to do next, and you'll have to think about the material you need and if you have enough nails, for example. It will take you about an hour to absorb as much information from the plans on the job site as you can in fifteen minutes off the job site. A good habit is to review the plans for ten minutes every morning away from the job site. You'd be surprised at how many mistakes are avoided by doing this.

Tool List

Tool	Location	Quantity
Framing saw	SB	1 per framer
Saw blades	H	Many
Cut saw	TB	2 per crew
Cut saw blades	FB	5 per crew
Impact wrench	TB	1 per crew
Impact sockets		
3/8″ for SDS 1/4″	MB	1 per crew
3/4″ for 1/2″ bolt	MB	1 per crew
15/16″ for 5/8″ bolt	MB	1 per crew
1 1/8″ for 3/4″ bolt	MB	1 per crew
1 5/16″ for 7/8″ bolt	MB	1 per crew
1 1/2″ for 1″ bolt	MB	1 per crew
1 13/16″ or 1 7/8″ for 1 1/4″ bolt	MB	1 per crew
Drill	TB	2 per crew
Drill bits		
5/8″	FB	2 per crew
3/4″	FB	2 per crew
7/8″	FB	2 per crew
Router	TB	1 per crew
Router bits		
Panel pilot	FB	2 per crew
1/2″ round	FB	1 per crew
Router wrench set	MB	1 per crew

Legend:
SB = Saw Box
H = Box
FT = Front of Truck
TB = Tool Box
SR = Screwdriver Rack
JH = Jay Hooks
MB = Metal Box
T = Truck
LB = Lock Box
FB = Flat Box
TT = Top of Truck

Tool	Location	Quantity
Chop saw	TB	1 per crew
Beam saw	TB	1 per crew
4-way electric cord	H	1 per crew
100′ electric cord	H	1-1/2 per framer
Nail gun	LB	1 per framer
GWB nail gun	LB	1 per crew
Air compressor	TB	1 per three framers
100′ air hose	H	1-1/2 per framer
2′ level	TT	1 per crew
4′ level	TT	1 per crew
8′ level	TT	1 per crew
Sledgehammer	FT	2 per crew
Crowbar	FT	2 per crew
Framing square	TT	1 per crew
Stair nuts set	FB	1 per crew
Glue gun	TB	2 per crew
Wall pullers	TB	2 per crew
Hand saw	H	1 per crew
Transit stand	FT	1 per crew
Transit	LB	1 per crew
100′ tape	FB	1 per crew
String line	TB	2 per crew
Water jug	T	1 per crew
Step ladder	T	1 per crew
Extension ladder	T	1 per crew
First aid kit	FT	1 per crew
Microwave	FT	1 per crew
Stereo	T	1 per crew

Tool List *(continued)*

Tool	Location	Quantity
Broom	T	1 per crew
Chalk bottle	T	1 per crew
Knife blades case	H	1 per crew
Vice grip	MB	1 per crew
5″ crescent wrench	MB	1 per crew
8″ crescent wrench	MB	1 per crew
Allen wrench set	MB	1 per crew
Screwdriver		
Standard	SR	2 per crew
Phillips	SR	2 per crew
PLUS		
Retractable safety line	JH	2 per crew
Lanyards	JH	4 per crew
Regulators	FB	½ per gun
Compressor oil	TB	1 per crew
Gun oil	TB	1 per crew
Plumb bob	FB	1 per crew
Electric three-way	FB	2 per crew
Air three-way	FB	2 per crew
Saw guides	FB	1 per crew
Screwdrivers	FB	Misc.
Chain saw	SB	1 per crew
Chain saw blades	FB	1 per crew
Palm nailer	LB	1 per crew
Ear plugs	FB	Misc.
Back support	JH	Misc.

5. **Schedule.** Developing a schedule is a difficult task, and one that should be a responsibility of the contractor. If, however, the framing contractor does not provide one, the lead framer should create his own. It is a valuable tool that will help you organize the job and then analyze how the work is going.

6. **Plan shack.** On bigger jobs, a plan shack is a good tool to have. It doesn't have to be fancy, but if it keeps your plans dry and helps keep the job organized, it is worth the time and material.

Plan shack

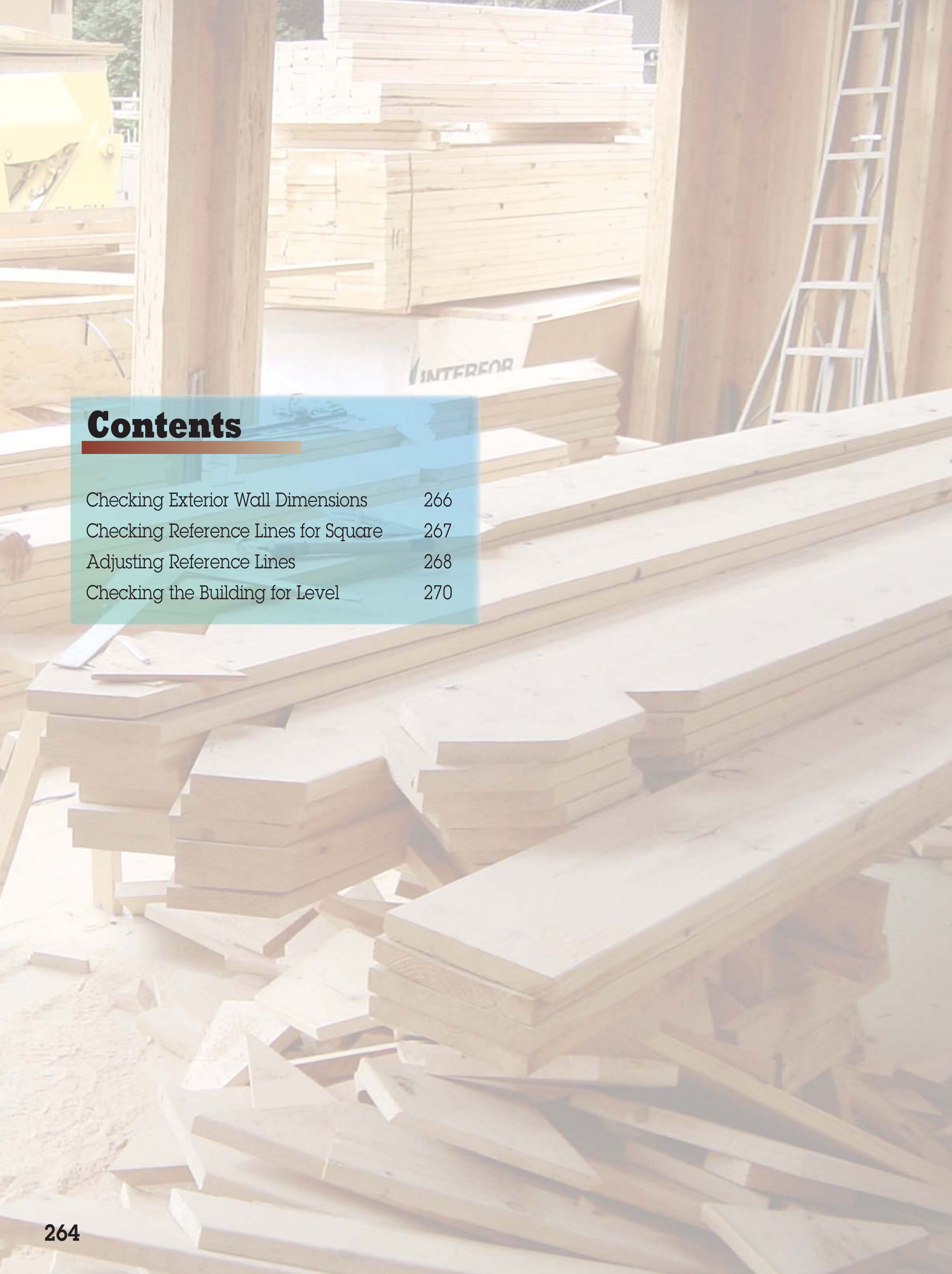
Conclusion

Your time spent preparing for a job sets the tone for managing the whole job. It lets you hit the job running and puts everyone on notice that you are serious about making this job run smoothly.

With a picture of the plans in your head, a job site check list complete and your tools organized you will start out answering questions and taking control of what needs to be done to get your project framed.

Chapter Thirteen

MANAGING THE FRAMING START



Contents

Checking Exterior Wall Dimensions 266
Checking Reference Lines for Square 267
Adjusting Reference Lines 268
Checking the Building for Level 270

Chapter Thirteen

MANAGING THE FRAMING START

Certain activities must take place before you begin framing. The dimensions and level of the foundation and slab need to be checked. If they are not perfectly level (which is not unusual), you must determine how far from correct they are, whether they are within tolerances, and what types of adjustments you must make. It is important that the dimensions are accurate, and the building is square before you start. Note, too, that the cabinets, floor covering, drywall, roof trusses or rafters, and much more depend on the measurements being accurate and square.

The four steps to getting started, covered in this chapter, are:

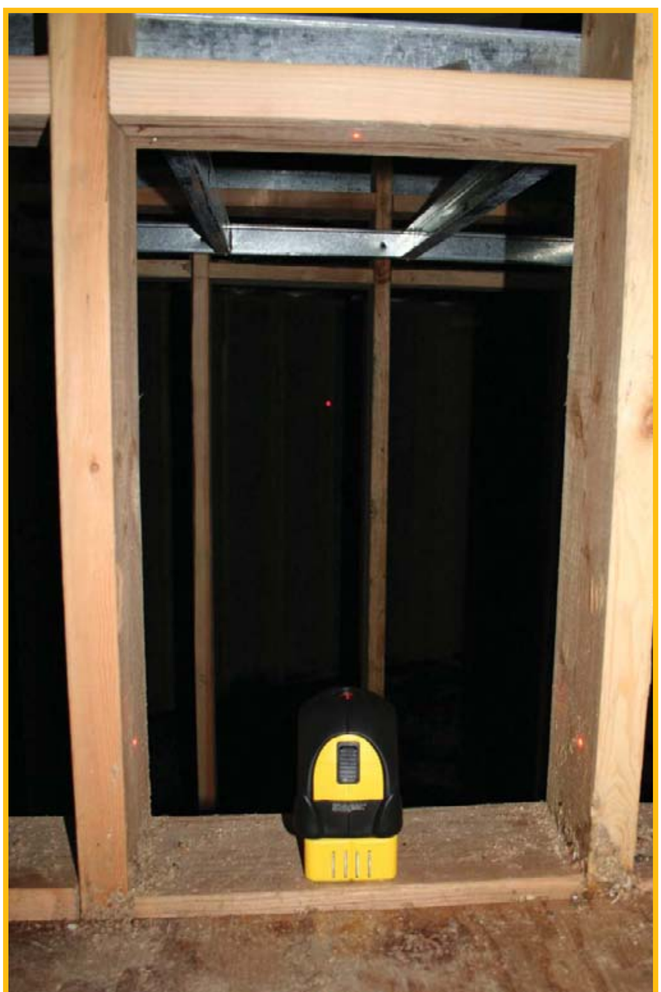
1. Checking the exterior wall dimensions
2. Checking the reference lines for square
3. Adjusting the reference lines to correct dimensions and square
4. Checking the building for level

Checking Exterior Wall Dimensions

If you have the concrete-work reference points handy, getting started will be easier for you. If you don't, establish reference lines of your own. Be sure to mark these lines well, since you will be using them throughout the job. Using clear marking paint in inverted cans makes it easy to protect your lines on the concrete.

You will want to use the reference lines to find any deviations from plan measurements or any out-of-square parts of the foundation. Start by stringing dry lines that will allow you to measure. The more of the building you can measure from these lines, the more likely you are to find any mistakes. Look at the plans, and string two dry lines perpendicular to each other and covering as long a distance of the building as possible. If you can add two more dry lines, one on each side and opposite to the first two, that will help. (See the "Start-Up" example.) Once you have established your lines, take measurements between the lines and to the major exterior walls in the building. Make a quick footprint of your building, and as you measure the distances, write them down on the footprint. (See "Footprint Sketch Dimensions" example later in this chapter.)

A laser can also be used to establish square lines. The laser will give you dots that you just need to connect. Set the laser up at a convenient position so you will be able to chalk reference lines. Once you have established the lines, use your tape and a 3-4-5 triangle to check for accuracy.



"Laser Dots." Note: a fifth laser dot would be visible under the back of the laser.

To check the exterior wall dimensions:

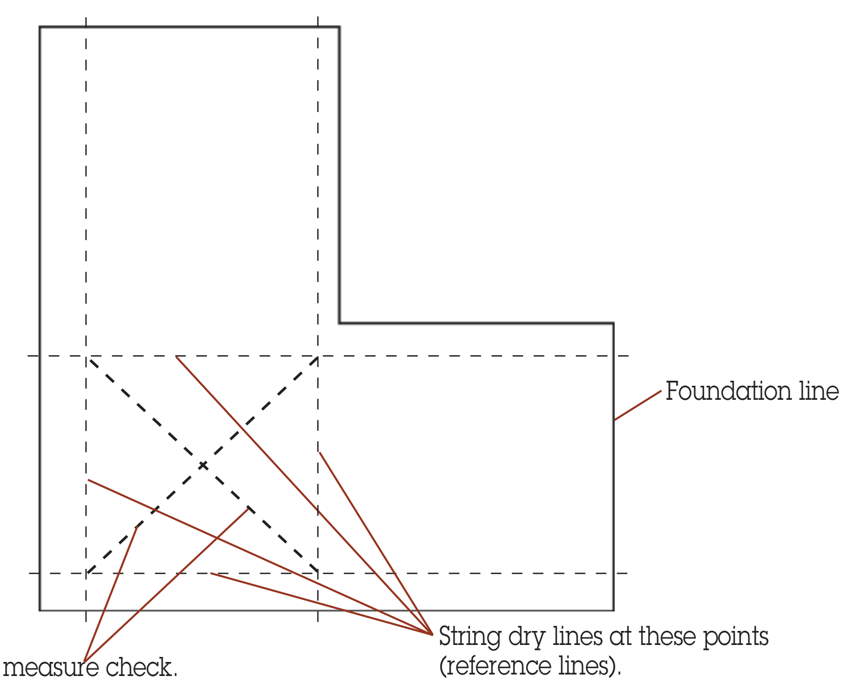
1. String dry lines to create reference lines.
   - Select lines that are as long as possible.
   - Locate line ends at extreme ends of the building.
   - Locate lines so that they reference the entire building.
2. Use reference lines to measure the building dimensions.
   - Check the exterior wall locations and note any discrepancies.

Checking Reference Lines for Square

To check using four reference lines, measure the two diagonals, then write down the measurements on the footprint you used for measuring the dimensions. If the corner points are set correctly, then the diagonals will be the same length. If the reference dry lines are square, then the diagonals will be the same length. (See "Start-up" example.)

If you have only two reference lines to work with, you'll need to use a triangle to help you check for square. The two reference lines will be "square" with each other if they create a right angle (90°). You can use a 3-4-5 triangle or the Pythagorean

Start-Up Example



theorem to determine whether the two reference lines create a 90° angle. In each case, the three sides (the rise, run, and diagonal) of a triangle must have a certain length relationship for the reference lines to be "square." Since we can let the two sides of the triangle be the reference lines and make them any length, it is the third line (the diagonal), which will determine if the reference lines are at a 90° angle.

A 3-4-5 triangle works well because as long as one angle is a right angle (90°), and the lines on either side of the right angle (the rise and run) have a relationship of 3 to 4, then the third side (the diagonal) is a 5 in the same relationship.

To use the triangle, use your reference dry lines to replicate a right angle, then create a triangle using the 3-4-5 relationship for the sides. To do this, measure a distance out on each reference string line from the point where the two lines intersect. The measurements of each leg should be a multiple of 3, 4, or 5. Note that the longer the length, the better assurance you have of accuracy. So if you are using a 25' tape, for example, measure out 20' on the one side and 15' on the other side. The distance between these two points—across the diagonal—should be 25'.

The Pythagorean Theorem system sounds a lot worse than it is. If you use a calculator like a Construction MasterPro®, all you need to know is that the three sides of the triangle are represented on the calculator by a "run" button, a "rise" button, and a "diagonal" button. You'll need to find the length of the third side of the triangle (diagonal) that is required to make the two reference lines square (90°). Enter into the calculator the lengths of the two sides of the triangle that are next to the angle that needs to be 90°. (Press the run button for the one side and the rise button for the other side.) Pressing the diagonal button will give you the length of the third side of the triangle. This length is the distance needed to have the reference lines square and the angle to be exactly 90º.

If the diagonal length is not what it is supposed to be, then write on the footprint how much over or under it is.

To check the reference lines: If you use four reference dry lines, check the diagonals. (See "Square Correction" example.)

- If you use two reference dry lines, use a triangle to check for square.
- Check for and note any discrepancies.

Adjusting Reference Lines

It is common that concrete foundations or slabs are not the exact dimensions that are shown on the plans. These need to be identified and corrected.

Common sense and experience are the best decision-making tools for approaching and correcting errors. Once you have your footprint sketch with the dimensions and square checks on it, you'll be able to determine if there are any errors.

If a diagonal line is too long, then some of the lines at the end of the diagonal must come in to make the diagonal the right length. (See "Square Correction" illustration.) Check the wall dimensions lines to see which lines can be shortened. Once you've determined the best way to make adjustments, speak to the superintendent about your suggestions. Typically, a fix will involve moving the wall in or out on the concrete foundation.

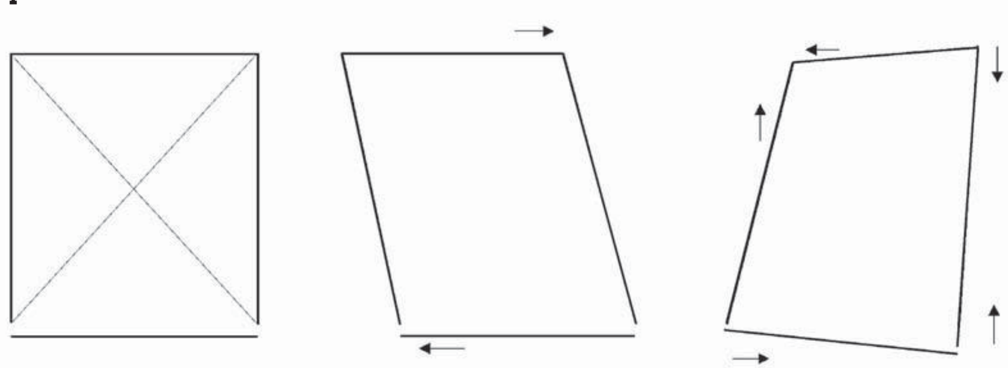
Depending on the finish, there is a certain tolerance that will allow for moving the walls without

affecting the appearance. It is common to have finish material that overhangs the foundation, so moving the wall out slightly may not be noticeable. It is also common to have the sheathing on the outside of the foundation, so that if the wall needs to come in, it can be adjusted in the thickness of the sheathing without affecting the look of the finish.

If corrections would cause visible errors in the finished building, then consider alternative measures. An example of a visible error would be if the concrete finish wall sticks out past the siding on the finished exterior wall. There are three methods that can be used to address errors in the foundation. These are as follows:

- Correct the foundation wall. This is the best solution, but often cost-prohibitive.
- Change the dimensions of the building. This is easy, but very often causes problems later on. Make sure to check that the change does not affect truss span if using roof trusses. Also, check to see that the change does not affect dimensions of items such as bathtubs or cabinets. If a change is made, make sure it is made on all copies of the plans.
- Do not correct the errors. Correcting the errors might cause more problems or imperfections in the building than the errors will.

Square Correction



Arrows indicate direction to move reference lines to help make reference lines square.

The “Footprint Sketch Dimensions” illustration is made on the job site. It will help determine how to best adjust your reference lines to make the building square. In this example, four dry lines are established to form a square. The diagonal distances that should be the same are then checked. Because they are different, the reference lines will need to be moved to make the diagonals the same. By comparing the actual and the planned dimensions of the walls that the reference lines are measured from, you can determine which reference lines should be moved. When you move a reference line, the other lines are affected.

If you have all the information down on your footprint sketch, you can come pretty close to knowing exactly how much to move each line, and keep making adjustments until you are comfortable with your accuracy. Once your reference lines are established, you can set all the other lines in the building from them. The measurements in circles on the sketch show the distance that the reference lines would be first moved. It is difficult to determine exact amounts because of the proportions, but if you study the footprint for a little while, you can come pretty close.

Checking the Building for Level

Using a transit or laser is the best way to check for level. A water level can also be used. Once a level foundation has been established, you are ready to cut, drill, and set the mudsill in place.

The foundation and/or slab should be ready for you to start framing when you first arrive. Sometimes, however, this is not the case, and time will be needed to “shoot” (measure using a transit or laser) a foundation and slab. Time must also be allotted to fix any problems in the concrete. It will be your responsibility to check and make a suggestion if you think corrective work is necessary. Start by checking and recording your findings. Record your findings in a way that lets you use the information if you decide the concrete needs corrective work. To record your findings, make a footprint sketch similar to the one you used for dimensions and squaring, and write the readings on the footprint. (See “Footprint Sketch Elevations” later in this chapter.)

To take the measurements using a transit, one framer should hold a tape measure at the spots to be measured, while another framer uses the transit to record the height to the transit line from the concrete. To take a measurement using a rotary laser, one framer records the measure at the spots to be measured using a detector that reads the laser beam.

Checking level using a rotary laser.

If you are working with a foundation wall or an existing wall, a rotary laser is efficient because once you have the laser set up, you can just mark the red line and measure up or down from it. If the concrete work is done well, typically within a variance of ¼", then just shooting at strategic locations on the concrete should be

sufficient to check for level. If you quickly find out that the concrete is not level, you will need to shoot the concrete every four to eight feet along the walls. Either way, be sure to record the measurements on the footprint sketch. Mark the locations where the measurements were taken. When you start building walls, you will use the measurements in the footprint and the marks on the concrete to determine stud heights. The marks are only made every 4'–8', because when you are laying out walls, a level can be used to find the heights between the marks. Another way to find the stud heights between marks is to use a chalk line at the top of the wall to rub studs against and mark the heights. (See "Chalk Line at Top of Wall" photo.)

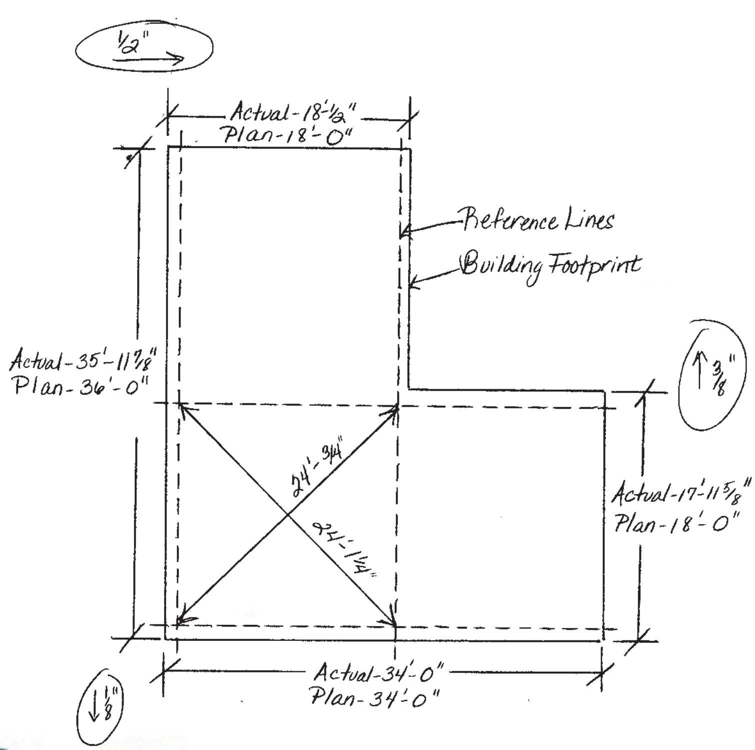
Once you have finished a footprint with the elevations marked, you can determine if any corrections need to be made. With the elevations written down, you can show the footprint to the superintendent or owner to let them decide what tolerance they will accept on their building.

If you look at the "Footprint Sketch Elevations" illustration, you will notice that most of the building elevations center around 49¼" and are within ¼". The top wall on the sketch, however, appears to be low, with the lowest point at 49⅝". Although 49⅝" is more than 49¼", it actually represents a low point, because the measurement represents the distance from the transit line down to the concrete.

Framer-Friendly Tips

When using chalk line to determine stud heights, be careful not to touch the chalk line with the stud before the stud is in position for an accurate cut.

Footprint Sketch Dimensions



On the footprint sketch example, you would probably want to use a height of 49¼" and recommend adjusting the section of the building that is low.

The Xs on the footprint represent the position of your tape measure when you shoot the height with the transit. Mark the X on the concrete so that when you start building walls, you will have a reference point if your heights need adjustment. Also keep your footprint sketch for this purpose.

Chalk line at top of wall

Finding Stud Heights for Different Height Foundations

Finding stud heights when the slab or foundation is not level is difficult. It is even more so when the foundation steps up or down to different heights. Using a transit requires you to measure everything from the height that is established when you set the transit. It could be measuring up or down from the transit reading line. It is hard to keep all the numbers in your head when you start adding and subtracting for the different concrete levels and the levels of the foundation.

The best way to find the individual stud heights is to write everything you need for each individual stud down on a piece of paper and figure the stud height from those figures. The illustration "Stud Heights for Different Foundations" illustrates how to do this and includes a "Job Site Worksheet." Whenever you move the transit, it changes the measurements, so you would have to start over if you did not have all the measurements you need for a particular area. It is easier to finish one area completely before moving the transit.

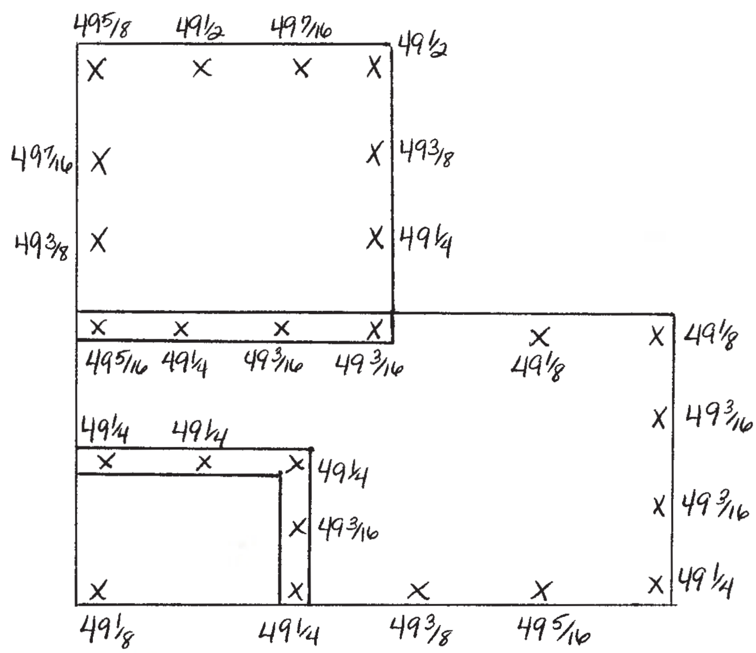
Transit line from concrete

When there is a foundation wall that is above a slab, it saves time if you chalk a level line on the foundation and then measure the stud heights from this line.

Framer-Friendly Tips

If the anchor bolts are bent, a piece of cast iron pipe works well to straighten them without banging up the threads or damaging the concrete. Slip the pipe over the bolt, and push until straight. The longer the pipe, the easier the push.

Footprint Sketch Elevations

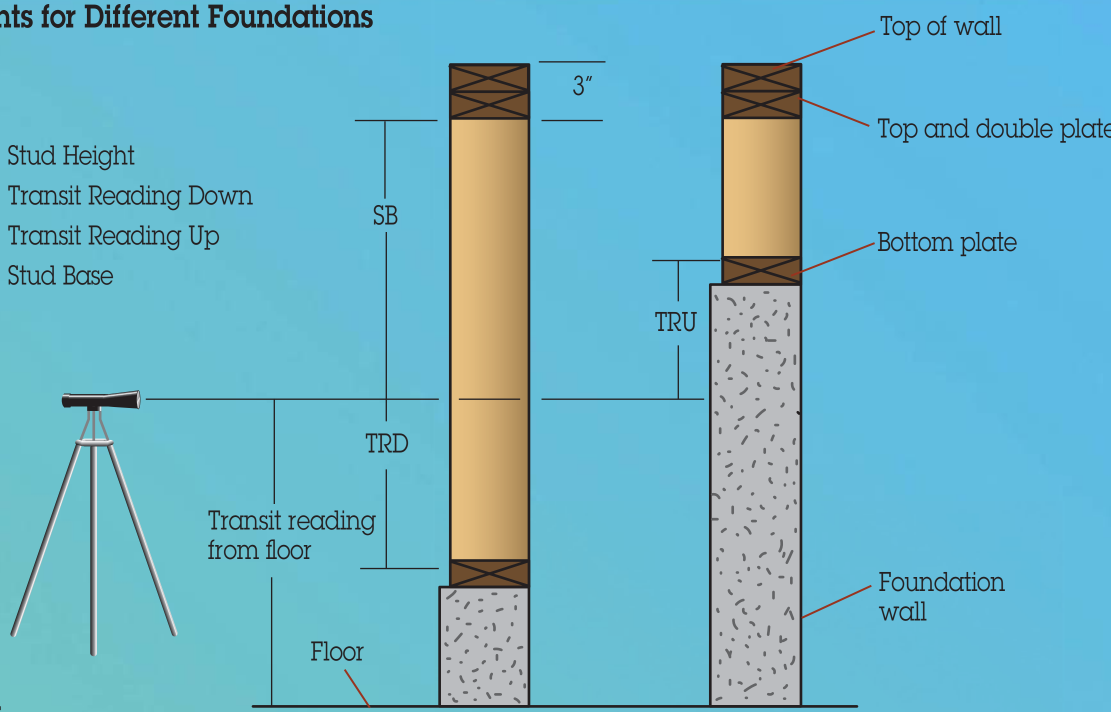


Conclusion

Before you begin framing, it's crucial to check your foundation and slab to make sure they are square. Once you have done this, you can move to the next step, the actual framing.

Stud Heights for Different Foundations

SH = Stud Height
TRD = Transit Reading Down
TRU = Transit Reading Up
SB = Stud Base



Equations

SH = TRD + SB

SH = SB – TRU

Steps

1. Set the bottom plate.
2. Find SB (stud base) by looking on the plans for height of wall; then subtract the height of the "Transit reading from floor" and the 3″ for top and double plate.

Job Site Worksheet				
TRD	+	SB	=	SH
SH1	+		=	
SH2	+		=	
SH3	+		=	
SH4	+		=	
SH5	+		=	
SH6	+		=	

	SB	–	TRU	=
SH7		–		=
SH8		–		=
SH9		–		=
SH10		–		=
SH11		–		=
SH12		–		=

Chapter Fourteen
MANAGING A FRAMING TEAM

Contents

Managing Your Team	278
The Role of Lead Framers	279
Quality Control	288
Organizing Tools & Materials	289
Teaching Framers	292
Framing Tips for Every Task	294
Planning & Scheduling	302
Recordkeeping	304
Productivity	306

Chapter Fourteen

MANAGING A FRAMING TEAM

This chapter is intended for advanced framers who are becoming "lead framers," or starting to manage a framing crew. Keep in mind that the lead framer's productivity is defined by the productivity of the crew. If you're taking on the job of lead framer, you'll need to think about the information your crew needs and how to teach and manage them most effectively. Earlier chapters in this book will help you train your crew in the specific steps of various framing tasks. But there are other aspects to managing a crew. It's the lead framer's job to get the building framed on time and within budget. The lead framer must also be sure that the expected quality standards are met, and that the building is structurally sound, visually aligned, and ready for inspectors and for other trades—all of this while maintaining a safe and congenial workplace. To meet all of these goals is an impressive accomplishment. The purpose of this chapter is to help you get there.

Management techniques have been developed over the years by studying and applying methods that work. The trend has been away from the dominating "command" approach and toward the cooperative "team" approach. This chapter deals with some organizational tasks, as well as with relationships and motivation. Developing good working relationships and instilling motivation is probably the most important and the most difficult task of a leader. A construction project manned by crews of skilled craftsmen who take pride in their work and get along with each other is bound to be successful. Assembling and directing such crews can only be accomplished by a leader who has developed good management skills.

Managing a framing team is a task like no other. The job changes every day and is always full of new surprises. The lead framer should be good at multi-tasking. A typical day might include trying to make sense of plans that don't provide enough information, dealing with an owner or general contractor who is focused more on cost and schedule than the details of framing, and organizing a group of framers who have different levels of knowledge and experience into an effective team.

The most valuable tools you can have in managing a crew are common sense, framing knowledge, the ability to evaluate a situation objectively, and an understanding of your crew's abilities and personalities. You probably already have a preferred management style, based on what you have learned in your experience in the field. This chapter will help you better understand that management style and improve upon it.

Managing Your Team

Construction is a unique industry. It is always changing. Each new job or building has its own individual plan, timetable, and workers to do the job. The economy, local governments, codes, tools, and materials are also constantly changing, creating different work environments. The crew structure has to change, as necessary, to accommodate the particular requirements of a job. To be efficient, the lead framer must be aware of all factors that affect the job, and must be able to work successfully within them.

The management structure of a framing crew can differ from company to company. In some cases, the lead framer is the owner/builder. In larger construction companies, the lead framer may run only the framing crew. Either way, the lead framer leads the framing on the job.

This book is not intended to cover the functions of the framing contractor or builder that include office management, bids, payroll, or business organization. It is written for someone who already has experience, knowledge, and skills in basic framing, and who wants to move up to the next level or become a better lead framer.

As a lead framer, you need to have a different perspective from a crew member. When you are working on your own, the amount of work completed depends on you. When you are leading a crew, the amount of work finished depends on the whole crew. On your own, you have complete control over what can be done, whereas you have limited control over how much work your crew gets done. Nevertheless, you only need a little control and increased knowledge to make a big difference in how much work the crew finishes. This chapter is intended to give you that increase in knowledge—which can make your jobs run better.

The lead framer

The Role of Lead Framers

A Lead Framer Must Possess:

1. Knowledge to frame any building
2. Ability to impart knowledge to other framers
3. Ability to motivate other framers

Knowledge to Frame Any Building

As a lead framer, you must thoroughly understand the basic concepts involved in framing any style building. The framing crew takes their direction from you; you, in turn, take your direction, depending on the situation, from any of the following:

a. Framing contractor
b. Site superintendent
c. Architect or engineer (plans)
d. Owner

There are a number of framing requirements that are easy to overlook. Compile checklists such as the ones shown and refer to them during each phase of the job.

Framing Checklist

Walls:

- ☐ Studs for tubs, medicine cabinets, etc.
- ☐ Special shear nailing
- ☐ Hold-downs
- ☐ Alignment of windows and doors
- ☐ Size of studs

Joists:

- ☐ Heading-off for toilets
- ☐ Double under bearing walls
- ☐ Cantilevering overhangs

Roof:

- ☐ Fascia overhang 6" for gutters
- ☐ Skylights or roof hatch
- ☐ Ventilation
- ☐ Attic access

Crawl space:

- ☐ Vents in rim joists
- ☐ Crawl space access

Responsibilities of Lead Framer

- ☐ Check location and quality of power supply.
- ☐ Check location and date of lumber drop.
- ☐ Check window delivery schedule.
- ☐ Check truss delivery schedule when appropriate.
- ☐ Arrange to have the builder complete as much site preparation as possible before starting, including leveling the area around the building where framers will be working.
- ☐ Highlight items on plans that are easy to miss or hard to find.
- ☐ Make a list of potential problem areas and items that are easy to forget.

Ability to Impart Knowledge to Other Framers

- When teaching someone, start with the basics. Assume nothing. Explain in clear and simple language exactly what the job is, and how it is to be done.
- The easiest way to lead may be to give orders, make demands, and threaten. However, it creates an unsettling atmosphere that is not conducive to a cooperative, self-motivated crew. *Request* that framers do tasks; do not *order* them.
- Assume that no framer intentionally does something wrong. Help your crew correct errors and show them how to avoid making them again.
- Treat each framer with respect. His time may be less valuable to the company, but his worth as an individual is equal to yours.
- The words "please" and "thank you" can make a framer feel much better about working for you. It is an easy way to let him know that what he does is important and appreciated.
- Do not give the hard, unpleasant jobs to the same framer time after time. The entire crew should share such tasks.
- When a framer asks you a question, give him the answer, but then explain how you got the answer so the next time he can figure it out himself.

Ability to Motivate Other Framers

To produce good work efficiently, a framer must be motivated. To be motivated, a framer must:

- Feel good about himself
- Feel what he is doing is important
- Be respected by his lead framer
- Feel he is being treated equally

Feel good about himself

You are a lead framer, not a therapist, but your attitude toward your crew should have a positive effect on his motivation. A crew whose members take pride in their individual and collective skills will invariably produce quality work and take pleasure in doing it.

Feel what he is doing is important

Every task, no matter how small, is necessary to complete the job and, therefore, important.

Be respected by his lead framer

Take time to listen and teach. If, as lead framer, you are called upon to solve a framing problem, it is better to let the framer explain his solution first and, if it is an acceptable solution, let him do it his way. There are often several ways to solve a framing problem. If you have a way that is much faster or easier than the framer's way, explain it to him and tell him how you came to your conclusion.

Directions should be given in terms of the job, not the individual. For example: *Negative*—"I told you five minutes ago to build that wall." *Positive*—"We need that wall built right away so we can finish this unit."

Framers like to feel that the person supervising is concerned about what they think and how they feel. Convey this through your words and actions.

Feel he is being treated equally

Don't show favoritism when assigning tasks. Make every effort to treat all framers fairly. Deal with any complaints impartially.

Different Types of Management

There are many ways to manage framers. It is important to know the different management styles and the effects that they have on employees, so that you can create the most productive framing crew. There are three main styles of management: *autocratic, bureaucratic,* and *democratic*.

Autocratic: The lead framer has the decision-making power and does not delegate authority. Discussion and suggestions are generally not permitted. This style sometimes motivates framers to please the lead framer instead of to improve productivity. It also discourages framers from finding creative solutions.

Bureaucratic: The lead framer enforces established rules, regulations, policies, and procedures to run the crew. This style does not allow for creative solutions.

Democratic: Framers help determine the goals of the company. The lead framer organizes and directs the framers as part of his job as a crew member. If a problem comes up between the lead framer and a framer, they work together to find a solution they can both accept. This style usually creates a congenial work atmosphere.

Most lead framers use a combination of the three styles. This lets them have authority when they need it, while getting the help from their framers in developing the most productive methods for accomplishing their work.

Managing a framing crew can be compared to playing quarterback on a football team. Your team has to have confidence in your ability to direct them. The team expects you to tell them when they make mistakes, but they also expect you to tell them what they need to know to do a good job and to be considerate of them. In effect, you have to develop a working relationship with each framer.

The autocratic lead framer

The democratic lead framer

Different Types of Framing Crews

There are different types of framing crews, which require some adjustment in style. They are:

1. Hourly employees
2. Piece workers
3. A combination of the two

Hourly workers are paid by the hour. Their goal is to keep their employer happy with their work. They typically are more concerned with quality of work than with speed. Piece workers are paid by the amount of work they finish. Their main goal is to get as much work as possible done within a certain time frame. A combination of the two allows for the employee to be paid for each hour he or she works, then to receive a bonus for completing extra work within a defined time frame. A combination system can provide the motivation to maintain speed, while still allowing you a great degree of control over the job.

More on Motivation

Motivation is the intangible factor that can make or break a crew, and probably the single most important factor that affects framers, yet it is not something you can demand of your crew. As a lead framer, you want to support individual framers and maintain a high level of motivation in the crew.

Ideas for Building Relationships and Motivation

1. Honesty is a basic. A framer will observe not only what you say and how you treat him or her, but what you say to others and how you treat them. Keep your framers well-informed. If there is a slow-down coming up, and some framers might be laid off, let them know. You risk the chance of them quitting before the job is finished, but if you want them to be on your side, you have to be on theirs.
2. The first day on a job is the most important time for setting a new framer's attitude toward his or her job. Take time to introduce him to the whole crew and show him where he can find tools, the first aid kit, and portable toilets. Allow time for him to acclimate to the job.
3. Developing relationships takes time and a conscious effort. While your time is valuable, and you have to balance it, try to listen to what your framers have to say, and show patience. If you want them to support your interests, you have to be concerned about theirs. Make yourself available and easy to talk to. Encourage open and free resolution of problems, and make every effort to use your framers' suggestions, or explain why if you decide not to. This gives the framers positive feedback and gets them thinking about better and faster ways to accomplish tasks. If you constantly reject their suggestions, you reduce their motivation.
4. Use power discreetly. The more you have to display authority, the less valuable it becomes. Persuasion and guidance can be more effective than a show of authority.
5. Assign more responsibility and train framers to take on new tasks whenever the job allows. This will motivate framers to take on more duties.
6. Teach framers how to solve problems.
7. Praise framers for good work. This helps create a positive attitude, especially when it is done publicly. Compliments are a good relationship-builder, especially when framers first start working with you. Go out of your way to find something they have done well. Hopefully you can get a couple of positive compliments in before you have to start pointing out any mistakes.
8. Expect some mistakes and use them as learning opportunities. Making mistakes and learning on the job are everyday occurrences and should not create fear in a framer. Your framers need to know that you are there to teach and direct them, and that you will be fair and reasonable.

9. Make criticism into a learning experience and give it in private. When a framer makes mistakes or is sloppy, don't assume it's intentional. Calmly explain what he did wrong. Direct the criticism at the action, not the person. Be specific. For example, "your nails are not sunk deep enough," instead of, "you are a horrible nailer." If the framer does not improve or change, then you may have to tell him that he is not suited for the work and should look for work elsewhere.
10. Pitch in and be a good example, especially if the job is one that nobody wants to do. You should not feel that any task is beneath you.
11. Be courteous. Everybody likes to hear "please" and "thank you." Saying "thank you" is a good way to finish up without giving the workers the sense that they are dismissed.

Respecting your framers will help keep them motivated, and help get the job done right.

Competition as a Motivator

It is sometimes possible to create competition that will provide enjoyment for your framers and increase productivity. Here is an example:

> *A while ago, I had a couple of hammers left over from tools I had purchased for a training class. On the job, we were framing a two-story hotel with two long walls on either side. I woke up one morning asking myself, "How can I make these walls go quicker?" I decided to create a competition by splitting the four framers into two teams, with one team on each side of the hotel. The winning team—the one that got their wall up first—would get the hammers. With the competition, the framers enjoyed the day and got a lot more wall framed than normal. Healthy competitions can help provide motivation.*

Goals

One of the best management tools is goal-setting. It develops motivation by creating a reason to work productively, gives you a tool for judging the productivity of a framer, and provides a benchmark for discussing each framer's daily tasks. Goals should be set for different time periods, ranging from the entire length of the job, to daily or task goals. Goals can be written down, or you can go over them in a conversation with your framers.

Goals for the job are usually defined in the beginning by your schedule and manpower.

It helps to break down your overall project goals into goals for each part of the job, like the first-floor walls, the joists, and the rafters. Once you know the goals for the major parts of the job, you can begin to set your daily goals.

Set daily goals the first thing in the morning. You might want to think about them and who you will assign to each task on your way to work. After assigning the tasks, ask each individual to set their own goals for the day, which you can review with them.

Framers sometimes think they can get more work done in a day than they actually can. In this case, all you have to do is agree with their goals, and encourage your framers to achieve them. If, on the other hand, they set their goals at a lower rate of productivity than you expect, review their goals with them, and see if you can teach them faster ways to achieve them. You might do a little of their work for them so they can see how fast it is supposed to be done.

If you can't agree on a goal with a framer, give him another task, and assign his original task to someone else. At the end of the day you can compare how much work the other person accomplished with what you and the first framer expected, then determine which one of you was more on-target. This takes time and effort on your part, but sometimes that's what's needed to create motivation—which will save time in the long run.

It's important to review goals when your framers are done with their tasks—either at the end of the day or the next morning before you set new goals. This will show framers that goals are important. It

also lets you determine when and if improvement is necessary. Set goals that are realistic and obtainable, but still challenging.

When setting goals, consider the learning curve. Studies have found that when you double the amount of similar work that someone does, their productivity increases by 20%. Even experienced framers have a learning curve.

The more experience you have, the clearer your goals will be. The more you set goals, the better you will become at it.

Company Goals

Job site goals need to be directed by overall company goals, which will vary depending on the owner's desires. Here are some examples:

Sample Company Goals:

1. To provide income for framers and the company
2. To provide a safe and enjoyable work environment
3. To coordinate with the general contractor's schedule and needs
4. To produce high-quality framed buildings
5. To grow the company
6. To develop framing skills

Communication

Communication is to a lead framer what a hammer is to a framer—one of your most important tools. Before you were a lead framer, you had to communicate with only one person—most likely the lead contractor or superintendent. As a lead framer, you will be communicating with these same people, but also possibly with the architect, engineer, owner, and the crew.

Each one of these people comes from a different environment, has different knowledge and experience, and different goals related to the job you are framing. Good communication is based on honesty, trustworthiness, openness, and effective listening skills. Keep in mind that bad communication *creates* problems, while good communication *solves* problems.

Communicating with Framers

Each framer who works for you will have his or her own unique characteristics, personality, background, and place of origin. It's probably impossible to know all the sides of all framers, but the more you get to know them, the easier it will be to communicate with and teach them.

Communicating with the Framing Contractor, Superintendent, Architect, Engineer, or Owner

We all know how to talk—some better than others. What we don't always know is what to say and who to say it to. That will vary depending on the size of the job and the organizational structure of the companies doing the building. If you say the right thing to the wrong person, or the wrong thing to the right person, you might end up causing yourself delays and/or additional work.

The nature of the construction industry lends itself to communication errors. With each new building, you might be working with a completely new group. In many cases, an owner will select the team that will design and build the building. The architect may have a great sense of how the finished building will look and feel, but probably won't be familiar with framing slang and concepts. The architect may hire an engineer to design the structural members of the building. Once the plans are complete, the owner will hire a builder who subcontracts the framing to your employer. You'll then have to frame the building based on plans that may have been passed around, worked on, and changed by a group of people who may not have worked together before, and who may have varying degrees of experience or knowledge of what you have to do to frame the building.

Solving Problems on the Plans

Chances are, there will be some mistakes, omissions, and/or details on the plans that just don't work. The parties involved in the design of the plans are capable of making mistakes in the same way you and your crew can make mistakes. Be ready to deal with these problems as they arise.

Good communication is probably your biggest strength when it comes to resolving mistakes or processing changes. The smaller the building, the easier it will be to navigate mistakes, and thereby reduce extra cost and time delays. Sometimes all it takes is a quick conversation with the superintendent. On bigger jobs, however, it may be necessary to get input from all members of the building management team, all the way back to the owner. In these cases, be sure to present the information in an organized way to prevent delays. The following five steps organize the process of solving problems with the plans:

1. Identify the problem: The information may be missing from the plans, or the design may just not work. It could also be that the information you need is in another part of the plans, not where it is usually located.
2. Have another framer review the situation: When you find a mistake, make sure it really is a mistake. One way to do this is to have one of your crew look at it. Even if he doesn't have the knowledge to fully analyze the situation, just explaining it to him helps you review it in your own mind.
3. Develop a solution: It is usually worth your time and energy to develop an easy solution and write it down. Very often your suggestion will be accepted. This saves the person who made the mistake from having to work out a solution—which could take days or even weeks and could be more difficult to frame than need be. Along with your proposed solution, you should note any extra costs that would result.
4. Identify and seek out the person responsible: Typically, if the mistake is in the architectural plans, it will be an architectural mistake. If it's in the structural plans, it's probably an engineering mistake. Quite often, however, it's a coordination mistake between the architect and the engineer. If you're lucky enough to have direct availability to the parties involved, a quick phone call might provide an easy solution. Remember that framing contractors, general contractors, architects, engineers, and owners all have relationships. Go to the source whenever possible, but be careful to go through proper channels for communication. Get permission, if necessary, to directly contact the appropriate party.
5. Clarify the solution: Each job has its own chain of authority. Sometimes the general contractor takes responsibility for solving problems; sometimes it's the owner or architect. Direct your suggested solution to whoever accepts the authority. Whether they agree with your solution or propose their own, be sure it is written down and dated, along with the name of the person who proposed the solution. Write it on the plans for easy reference. Do this while the person is still there to make sure you understand their interpretation of the solution. This way, you'll be protecting yourself in case of any future confusion.

Delayed Communications

Organizing your communication is another important task of a lead framer. For example, you might realize that you need more material or hardware, but the person who orders it is not on the site. By the time you see that person, however, you are onto another task and may forget to let them know what you need.

The easiest way to avoid this problem is to carry a small notebook in your pocket, and write down what you need, whether it's information or materials. Get used to checking your notebook whenever you talk to the people who supply your material or process your change orders, or when you are making phone calls. The notebook acts as a memory aid when communications are delayed.

Assigning Framers Tasks

As lead framer, your most important job is to assign framers to tasks. If they are unfamiliar with the tasks, it's part of your job to teach them how to do the work. It may be tempting to just grab the right tool and take care of the problem yourself, but if you don't teach your crew, they won't be able to work independently, and neither will you.

Organizing your crew and assigning tasks can be the easiest part of your job, or it can be the most difficult. A lot of it has to do with the framers you have working for you, and the way you manage them. For example, one individual with a bad attitude can disrupt a whole crew, or a crew without proper direction can work all day and get little done.

When you first start leading, you'll quickly realize that it takes a lot of preparation to keep the whole crew busy all the time. As each framer finishes a task, you must have another task ready. If a task isn't ready, the framer(s) will have to wait around while you get it ready for them.

Dealing with Difficult Personalities

Chances are you will have to work with a difficult framer at some time. Common sense and creative thinking are good tools in these situations. Here are some difficult personality types:

- **The Complainer:** Looks for problems, not solutions. Suggestion: Tell him complaints are not helpful, he should look for a solution, and if he gets stumped, you're there to help.
- **The Back-Stabber:** Disrespectful and might wish to be lead framer. Suggestion: Confront disrespect or underhanded behavior openly. Explain to him how his actions affect the whole team. If you can't resolve the issues, speak to the framing or general contractor.
- **The Talker:** Probably a nice person, but as long as he keeps you talking, he isn't working. Suggestion: Be considerate, but after a short while, excuse yourself to get some work done.
- **The Perfectionist:** Wants every task done according to his standards and lets everyone know if something is less than perfect. Suggestion: Use this person's keen eye to uncover potential problems. Let him be a sounding board for new tasks.

In some cases, "difficult" framers may just have personalities that require relating to them a little differently. Try to use the individual strengths of each framer for the betterment of the team.

If you are working on a task and one of your crew needs something to do (and you don't have anything else for him to do), show him what you are doing so that he can help you or take over. Or have him get started on the next phase of the job. The point here is that if anyone is going to be standing around scratching his head, it should be you, because you can always use the time to plan for the next step.

Analysis of Crew Performance

For your framers to become better framers, they should have an understanding of how well (or not) they are performing their jobs. Crew analysis is the process of answering this question. It is important to know the capabilities of each framer, so you can assign him to the kind of task where he'll be most productive and know how much supervision or instruction he needs. Discuss these things with your framers. Their feedback will help you understand and evaluate them.

The "Framer Analysis" form can be used to evaluate your crew and to show your framers what aspects of their work are important to you. This is also a good format for deciding wage increases based on performance. The framer who consistently gets high ratings may get more money if he reaches a certain skill level.

To use the form, give the framer a rating from 1 to 10 for all the items listed. The "Value Factor" column in this form is an estimate of the comparative value of the productivity items. You can change these values to your own preferences. Enter your rating in the column titled "Framing Rating 1 to 10." Multiply the rating by the various value factors and put the results in the column labeled "Total." Add the total ratings. This will give you a value you can use to compare your framers' performance. You can use the Framer Analysis form for your own planning purposes or to show framers where they need to make improvements.

Framer Analysis

	Value Factor	×	Framer Rating 1 to 10	=	Total
Productivity					
1) Speed	7	×	________	=	________
2) Framing Knowledge	6	×	________	=	________
3) Framing Accuracy	5	×	________	=	________
4) Ability to use Framing Flow	4	×	________	=	________
5) Endurance	3	×	________	=	________
6) Consistency	2	×	________	=	________
7) Rate of Learning	1	×	________	=	________
Effect on Productivity of Other Framers					
1) Respect for Lead Framer	3	×	________	=	________
2) Cooperative	2	×	________	=	________
3) Positive Attitude	1	×	________	=	________
Effect on Efficiency of Company					
1) Attendance	4	×	________	=	________
2) Positive Attitude	3	×	________	=	________
3) Follows Safety Rules	2	×	________	=	________
4) Truck and Job Site Neatness	1	×	________	=	________
TOTALS					

Quality Control

In framing, the question of speed versus quality always comes up. You want to get the job done as fast as possible—but you must have a quality building, and quality takes time. The most important thing to consider is the structural integrity of the building. Once that requirement is satisfied, the faster the job can be done, the better.

It is a lot easier to talk about the importance of quality than it is to define it for a framer. Quality to one framer can be the product of a "wood butcher" to another framer. Framers learn under different lead framers who have different goals and objectives, and different standards of what quality workmanship is. You need to establish your own definition of quality of workmanship for the framers working for you.

The best way to do this is by observing or auditing their completed work, then giving them feedback on what you saw and what you would like to see. To audit the work, check a portion of what has been done. If that sample is done well, most likely the rest is done right. If you find a mistake, find out why it was made, correct any similar errors, and make sure the framer knows why this happened.

Audit Checklist

A checklist is helpful when you audit individual tasks. It will help you remember all the parts that need checking. For example, the following list could be used for shear walls.

Framer-Friendly Tips

Whenever possible, allow the framer to fix their own mistakes. It's a great teaching tool.

Audit Guidelines

The following guidelines can be used to control the quality of experienced and new framers' work, and the work at the end of the job.

For an experienced framer you have worked with before:

1. Casually observe as part of routine.
2. Audit work after completion, or at regular intervals.

For new-to-the-task framers:

1. Review framing tips (at the end of this chapter).
2. When possible, demonstrate work.
3. Watch as the new framer gets started.
4. Ask the new framer to come and get you for review after the first piece is finished.
5. After a half hour to an hour, review the work.
6. End of day: review the work.
7. End of task: audit the work.

End of job:

1. Audit 10% of each individual task.
2. If mistakes are found, review all task work.
3. Correct all mistakes.
4. Check for omissions.

Shear Walls Checklist

- ☐ Nailing pattern for sheathing
- ☐ Blocking, if required
- ☐ Distance between sheathing nails and the edge ($^3/_8$" minimum)
- ☐ Nails are not driven too deep
- ☐ Lumber grade, if specified
- ☐ Hold-down sizes and location
- ☐ Hold-down bolt sizes
- ☐ Tightness of bolts

Sample Pick-Up Checklist

- ☐ Studs under beams
- ☐ Drywall backing
- ☐ Fireblocking
- ☐ Nailing sheathing
- ☐ Headers furred out
- ☐ Thresholds cut
- ☐ Crawl space access
- ☐ Attic access
- ☐ Dimensions of rough openings on doors and windows
- ☐ Check door openings for plumb
- ☐ Drop ceilings and soffits framed
- ☐ Stair handrail backing
- ☐ All temporary braces removed
- ☐ Joist hangers and timber connectors

Pick-Up Lists

Pick-up lists are important to keep things organized at the end of the job. The superintendent typically creates this list of tasks that have to be done before you are finished with the job. When the list is first given to you, review it to make sure everything is clear to you. It is sometimes easiest to ask the superintendent to accompany you around the site to make sure you understand exactly what he is trying to communicate.

You may have to consult the plans to get all the information you need in order to understand the work that needs to be done. If the superintendent does not have a written list, make your own list as you walk around the site discussing each task.

Remember that quality control is not just for the owner's benefit in the finished product. Quality control also makes your work go more smoothly. When your framers' cuts are square and true to length, the framing fits together a lot more easily. If the building is square, when you cut joists and rafters, you can cut them all at once, the same length, instead of having to measure each one. When you get to the roof, the trusses will fit.

Organizing Tools & Materials

In addition to organizing and teaching the crew, you will have to organize your tools and materials. Each crew and job will require a different type of organization. To give you an idea of how to go about this, we will discuss three aspects: *tool organization, material storage,* and *material protection.*

Tool Organization

Following is an example of how the crew's tools might be organized using a job site tool truck.

Clear descriptions are important on pick-up lists. If you don't have a detailed pick-up list, you can count on returning to the job to fix at least one task.

General

Put tools away, in their designated place, after using them.

- Hang safety harnesses and lines on hooks.
- Stand sledge hammers and metal bars in corner.
- Place saws on saw table.
- Place nail guns in safety box.
- Place electrical tools in wood box.
- Hang up screwdrivers.
- Place metal wrenches and sockets in metal box.
- Place nails out of weather.
- Place trash in designated container.

Roll-up

Roll up largest, bulkiest items first.

- Four-way electric extension cords
- Air hoses
- Electric cords

Take equipment to truck in following order:

- Miscellaneous hand electrical tools
- Air hoses and electric cords
- Circular saws and old saw blades
- Air compressors (Drain every Friday.)
- Ladders

The person responsible for the truck:

- As soon as roll-up begins, start picking up and taking tools to the truck.
- Take tools from framers and put them in their place in the tool truck.
- Clean/organize truck when not busy putting tools away.
  — Put similar nails together.
  — Hang up rain gear.
  — Put tools in proper place.
  — Check and account for number of tools.
  — Put all loose garbage in bucket.

Nails

- Use up partial boxes of nails first.
- Follow established storage procedures. For example, starting at the right-hand side of back of truck
  — 1st: 16d sinkers 4th: joist hanger nails
  — 2nd: 8d sinkers 5th: concrete nails
  — 3rd: roofing nails 6th: fascia nails
- On right-hand side under seat, 10d gun nails.
- On left-hand side under seat, 8d gun nails.

Roll-out

- Check oil in air compressors every morning.
- Oil nail guns every morning.
- Check oil in circular saws the first of every month.
- Check staging and ladders.
- Check safety devices in all tools.

This list should be discussed at the first crew meeting on the job, then the list should be posted on the tool truck.

Material Storage

1. If your lumber is being dropped by a truck, check to make sure the lumber is loaded so that the items being used first are on top. You might need to contact (or have the superintendent contact) the lumber company to make sure they think about the loading order. Sometimes it helps to make up a quick list to help them out. For example:
    - Treated mudsill plate
    - Floor joists
    - Floor sheathing
    - Wall plates
    - Studs
    - Headers
    - Wall sheathing
    - Rafters
    - Roof sheathing

    The lumber company may not be able to load the material exactly the way you want, but a little concern for the loading order can make a big difference in the amount of lumber you have to move.
2. When using a forklift, store like items together so that you do not have to move other material to get at what you need.
3. When storing items, always think about where you are going to use them. If you don't have a forklift, store them as close to where you are going to use them as possible.
4. If you have to store items in front of each other, make sure the items needed first are available first.
5. Consider using carts or other mobile devices for moving lumber in the building.

Pallet jack and drywall cart for moving lumber

Material Protection

Material protection also requires you to consider accessibility and time. You can spend a lot of needless time moving and protecting material. You can also end up reducing the quality of your building by not taking care of your material. Consider the following:

1. If the specifications indicate a certain procedure for protecting your material (usually the case on larger jobs), then you need to follow them.
2. Use scrap lumber to keep your material out of the dirt.
3. If lumber is left in direct sun, the exposed sides will dry out more than the unexposed sides, and cause it to warp. The warp will make framing difficult, and walls curved.
4. Moisture loss or absorption from lumber causes shrinkage or swelling. If the shrinkage or swelling is uneven or happens too quickly, the wood fibers can break and cause the lumber to warp.
5. Fungal growth occurs when moisture content reaches 20%, and the air temperature is between 40 and 100 degrees. Fungal growth causes decay and stain.
6. The moisture content of green lumber is little affected by rainfall. But if it is not used right away, green lumber is more susceptible to fungal decay and stain.
7. Posts, beams, and timbers are always green. Seasoning checks will occur, but will not affect the structural performance. The more this lumber is protected, the less it will check, and the easier the installation will be.
8. Always cover lumber if you are expecting snow or other bad weather. It is easy to lift the cover to remove the snow when you need to use the lumber. On the other hand, if the lumber is being used up quickly and is not adversely affected by the environment, covering it may be a waste of time.
9. If lumber is delivered with covers already on, leave them in place as long as possible. If you are using only small quantities at a time, consider pulling the lumber out at the ends to leave the cover on. With engineered wood products such as glu-lam beams, you may be able to just uncover the ends for bearing.
10. If moisture absorption is expected on full bundles of sheathing, cut the banding to prevent edge damage due to expansion of the sheathing.
11. When lumber is covered, allow ventilation so that the sun does not create a greenhouse effect that will promote mold growth.

Teaching Framers

You have to take training seriously if you want your framers to take learning seriously. You are a teacher whether you want to be or not. The only question is whether you are a good teacher.

Good teachers have confidence in their knowledge and an understanding of those working for them. Remember:

- A picture is worth 10,000 words.
- A demonstration is worth 100 pictures.
- Tell your framers what you are going to tell them, tell them, then tell them what you told them. Repetition makes learning easier.
- It is important that framers understand the structural significance of their work.

Some of your teaching will apply to all of your crew. For example, special nailing may be specified for double wall plate joints for the whole building. A crew meeting is a good time to inform the whole crew all at once.

Hold a crew meeting before you start a job, then once a week after that. Monday morning meetings can help ease everyone back from the weekend. You can have these meetings right before or after your safety meetings, while you already have everyone together. It's nice if the crew meeting can be a relaxed time, while still covering important points such as:

- Task assignments
- Crew procedures (crew organization)
- Tool organization (tool truck)
- Job-specific items

Teaching While Assigning Tasks

Most of your teaching will occur when you are assigning tasks to framers. You won't have to say anything to your experienced framers, but new or apprentice framers benefit from seeing you follow a certain procedure to make sure you don't forget anything.

When assigning a task:

- Always assume your framers are seeing the task for the first time.
- Explain everything you know about the operation.
- As you're explaining the operation, tell your framers why it's done this way.
- Ask them if they understand. (Have them explain it to you.)
- If they ask you a question and you don't have the answer, tell them you'll find out and get back to them.

Check on them:

- After five to ten minutes.
- Repeatedly until you're confident that they know what they're doing.

When you're teaching a framer trainee, remember that they're learning as a student, so expect that it may take a little while for them to catch on. Don't expect all trainees to learn instantly, but always assume they want to learn.

The best way to communicate how to do a job is to actually do the job, and let the trainee watch. At the same time, explain as much of what you're doing as possible.

If you are showing an apprentice how to nail off plywood, use the following sequence:

1. Tell them the nailing pattern.
2. Ask them if they know what "nailing pattern" means.
3. Tell them about keeping the nail 3/8" away from the edge of the plywood.
4. Tell them to angle the nail slightly toward the edge of the plywood.
5. Tell them when they need to use a regulator or depth gage, and show them how.
6. Tell them how to avoid breaking the plywood surface.
7. Demonstrate use of a nail gun.
8. Watch them while they shoot a couple of nails in.
9. Ask them to come and get you to check their work after they have finished two sheets.
10. Check their work closely to make sure it's done properly.

Using this type of checklist will help you remember all the items that should be covered. This list also helps with assigning framing tasks.

Framing Tips for Every Task

When the lead framer is assigning tasks, he has to decide what information he has to tell the framer before starting the task. If the crew member has never done the task, the lead framer needs to explain it. If the framer has done this task many times, little needs to be said. If the framer's knowledge is not clear, it's best to review the task with him.

There are certain "tips" that experienced framers have developed for each task. Use the ones provided in this section or keep your own list to help your crew members.

Use your legs to support studs while spreading.

Building Wall Tips

Material Movement for Walls

1. Locate wall framing so that once the wall is built, it can be raised into position as close to where it finally goes as possible.
2. Spread the headers, trimmers, cripples, and sills as close to their final position as possible.
3. Eight is an average number of 2 × 4 studs to carry.
4. You can use your leg to stabilize the studs you are spreading. Stabilize them with one arm and one leg to free up your other arm so that you can spread them one at a time. This way you won't have to set them down, then pick them back up to spread them. (See photo.)
5. Select a straight plate for the top and double plates, and position any crown in the double plate in the opposite direction of the top plate crown. This will help straighten out the wall.

Nailing Walls

1. Nail the headers to the studs first. Make sure that they are flush on top and on the ends of the headers.
2. Nail the trimmers to the studs. Make sure that they are up tight against the bottom of the header and flush with the sides of the stud.
3. Nail the studs and cripples to the plates. Nail sills to the cripples and the trimmers. Make sure that all the connections are tight and flush.

Teaching wall-building

Squaring Walls

1. Align the bottom plate so that when it is raised, it will be as close to the final position as possible.
2. Attach the bottom plate to the floor along the inside chalk line for the wall. Toenail through the bottom plate into the floor so that the sheathing won't cover the nails. If the wall is in position, it can be nailed on the inside, and the nails can be pulled out after the wall is raised.
3. Use your tape measure to check the diagonal lengths of the wall.
4. Move the top part of the wall until the diagonal lengths are equal. Example: If the diagonal measurements are different by one inch, then move the long measure toward the short measure by one half inch diagonal measure. Make sure the measurements are exact.
5. Once the diagonals are the same, check by measuring the other diagonal.
6. Temporarily nail the top of the wall so that it will not move while you are sheathing it. Make sure you nail so that your nails won't be covered by the sheathing.

Teaching joisting

Joisting Tips

Material Movement for Joists

1. Material movement is a major part of installing joists.
2. Always carry the joists crown-up. This way, you can spread the joists in place, in the right direction, without having to look for the crown a second time. It's easier to look for the crown on the lumber pile than when it is on the wall.
3. Check on the size of joists and positions needed. Try to spread the joists on the top of the pile first so you won't have to restack them.
4. Check your carrying path for the joists. Sometimes you can reduce your overall time by making a simple ramp or laying a joist perpendicular to those already in place.

Cutting Joists to Length

1. Cut joists after spreading.
   - Spread joists on layout, and tight to rim joists.
   - Chalk cut line.
   - Lift and cut each joist in sequence.
2. Cut joist on lumber stack.
   - Measure joist lengths.
   - Cut multiple joists on lumber pile.

Nailing Joists

1. Position joist on layout and plumb.
2. Nail through rim joist into joists, making sure joist is plumb.
3. Toenail through joist into double plate. Nail away from end of joist to prevent splitting.

Framing Tips *(continued)*

Rafter Tips

Cutting Rafters

1. Figure cut lines for rafters, and check measurements before cutting.
2. Install common rafters first.
3. Cut three rafters.
4. Check two to see if they fit. If they fit, leave them in place and use the third as a pattern for remaining cuts. If they don't fit, cut to fit or save for hip or valley jacks.
5. Cut balance of common rafters and install.

Installing Ridge Board

1. Figure height for ridge board.
2. Install temporary supports for the ridge board.
3. Install ridge board.

Nailing Rafters

1. Toenail common rafters on layout into double plate.
2. Nail on layout through ridge board into rafter.
3. Cut hip and valley rafters.
4. Cut jack rafters.
5. Set and nail hip or valley rafter.
6. String line centerline of hip or valley.
7. Layout hip or valley rafter.
8. Toenail jack rafter on layout through rafter into double plate.
9. Nail jack rafter to hip or valley rafter.

Sheathing Tips

Floor Sheathing

1. Make sure the first piece goes on square.
2. Chalk a line using a reference line and the longest part of the building possible.
3. Align the short edge of the plywood with interior joists, the long edge with the rim.
4. Pull the layout from secured interior joists.
5. Nail the plywood to align with the chalk line and layout marks.

Teaching rafters

Framing Tips *(continued)*

Wall Sheathing After Walls are Standing

1. Make sure the first piece goes up plumb. If you are installing more than three pieces in a row, use a level to set the first piece plumb.
2. It is easier to install the plywood if you are able to fit a 16d nail between the concrete foundation and the mudsill.
   a. Place two nails under each piece near each end.
   b. Remove the nails when you are finished.
3. The easiest and fastest way to handle an opening in the wall is to just sheath over it, then come back and use a panel pilot router bit to cut out the sheathing.

Roof Sheathing

1. Make sure the first piece goes on square.
2. Chalk a line from one end of the roof to the other.
   - When measuring for the chalk line, make sure you consider how the plywood intersects with the fascia. The plywood may cover the fascia, or the fascia may hide it.
3. If the sheathing overhang is exposed, the sheathing could take a special finish.
   - If the exposed sheathing is more expensive than the unexposed sheathing, then often the exposed sheathing is cut to fit only the exposed area. In this situation, cut the sheathing so that it breaks in the middle of the truss or rafter blocking.
4. 24" is the minimum width of any row of sheathing. Check before you get to the last row in case you need to cut a row so the last row will be at least 24".

Nailing Sheathing

1. Read the information on the stamp on each piece of plywood. Make sure you are using the right grade. Sometimes the stamp will tell which side should be up.
2. There should be at least a $^1/_8$" gap between sheets for expansion.
3. The heads of the nails must be at least $^3/_8$" from the edge of the sheathing.
4. Make sure that the nail head does not go so deep that it breaks the top veneer of the sheathing. Control nail gun pressure with a pressure gage or depth gage.
5. Angle the nail slightly so that it won't miss the joist, stud, or rafter.
6. Use the building code pattern for walls, floors, and roofs. Always check the plans for special nailing patterns. (Most shear walls have special patterns.)

Teaching sheathing

Installing Hold-Downs (while walls are being built)

1. Locate wall hold-downs on plans and check details.
2. Locate holes to be drilled for hold-downs, anchor bolts, and through-bolts.
    - Measure location for through-bolts.
    - Center hold-downs on plates.
    - Center hold-downs in post or align with anchor bolts.
3. Drill holes.
4. Nail post into wall.
5. Nail sheathing to wall.
6. After wall is standing, install hold-downs, bolts, washers, nuts, and through-bolts.
7. Tighten all bolts and nuts.

Installing Hold-Downs (after walls are built)

1. Select a work area (large, close to material).
2. Check the plans for the location, quantity, and other details of hold-downs.
3. Collect all material and tools needed.
4. Spread hold-down posts for common drilling (Cut if necessary.)
5. Mark hold-down posts for drilling.
6. Drill for posts with holes $^{1}/_{16}$" larger than the bolts.
7. Loosely attach hold-downs, bolts, washers, and nuts to posts.
8. Spread hold-downs to installation location.
9. Drill holes for through-bolts if necessary.
10. Place hold-down in wall.
11. Place through-bolts into hold-downs where required.
12. Tighten all nuts.
13. Nail posts to plates.
14. Nail sheathing to posts.

Teaching installing hold-downs after walls are built

Framer-Friendly Tips

It is best to install hold-downs as walls are built so you don't have to worry about plumbers and electricians getting their pipes and wires in your way.

Teaching installing hold-downs while walls are being built

Removing Temporary Braces

1. Remove temporary braces only after the walls have been secured so that they will not move.
2. A sledgehammer provides a fast and easy way to remove the braces.
3. Knock a number of the braces off at one time. Be careful that no one steps on the nails before you remove them.
4. Put the removed braces together.
5. Hit the point end of the nail to expose the nail head.
6. Use a crowbar to remove the nails.
7. If you do not have many braces, a hammer is an easy way to remove them.

Teaching removing braces

Framing Tips *(continued)*

Material Organization and Cutting

Material Organization, Mitre Saw

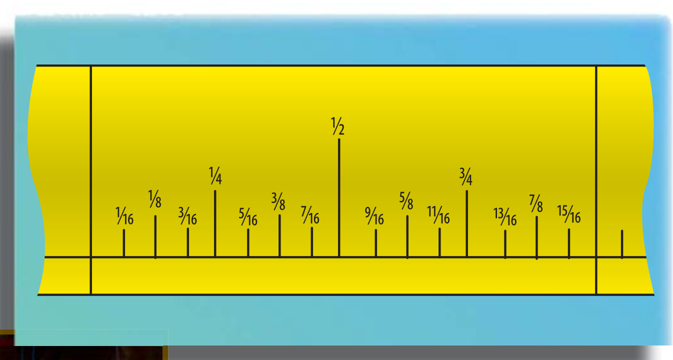
1. Set up your table in convenient locations for moving lumber in and out.
2. Place the incoming material as close as possible to the side of the saw where you will be positioning it to cut.
3. As it is cut, stack the lumber in a pile that is neat and easy to pick up and carry or lift with a forklift.
4. Put scrap wood that you will be cutting into stacks nearby, maybe under the saw table.

Cutting with a Mitre Saw

1. Set your length gage for multiple cuts.
2. Cut your first piece, then check the cut for square (both vertical and horizontal) and correct length.
3. Check the second and tenth piece for square and length.
4. Check every tenth piece after that for length.
5. Keep lumber tight against lumber guides, but don't bang them so that they move.
6. Remove any sawdust near the guides.
7. Respect the saw! If you don't, there is a good chance you will hurt yourself or your fellow framers.

Fractions

Many apprentice framers are not familiar with fractions, and some might be embarrassed to admit this. It doesn't take long to teach fractions. Ask the framer to show you where 11/16" is on the tape. If he can't do it easily, draw a duplicate of a tape showing the different length lines. Mark the fractions on each line, and tell him to take it home and memorize it. Review as frequently as required to develop proficiency.



Reading a tape measure

Teaching mitre saw

Planning & Scheduling

While lead framers are not responsible for developing project costs or schedules, they are asked for input into the decisions of others who must estimate and schedule construction. The superintendent, for example, might need to know if he can meet a deadline with the crew that is in place; a lead carpenter might need to know if there is enough material available to complete the job; or the framing contractor might need to know if any labor can be spared to send to another job.

To answer these questions, the lead carpenter must understand and appreciate the importance of the construction schedule and budget. This means thinking ahead and looking at the project as a whole, while also focusing on the details. It means evaluating the crew's ability to perform its job at a particular time under a given set of conditions.

Using the Crew Effectively

A crew includes both labor and equipment required to install materials. On any given day, the makeup of the crew can change. One person may not show up or may be sent to another job. At other times you may have to absorb extra manpower on short notice. Equipment you expected to have available may not be there or, with little notice, you may have the benefit of equipment. When faced with these situations, a seasoned lead framer draws on his or her experience and makes the necessary adjustments to either *push* the job or, at the very least, maintain the momentum.

Staying on Schedule

The lead framer should understand the labor hours required for each task, and be able to know in his or her mind if the schedule is realistic and can be maintained. Perhaps more important is recognizing potential problems before they become real problems. In a matter of hours, what seems to be a minor glitch can become devastating to the schedule. For example, if fuel has not been requested for a piece of equipment, production may be forced to stop while waiting for a fuel delivery.

Never underestimate the importance of realistically measuring the crew's ability to perform the work. Keep in mind that most jobs, unless very short in duration, are scheduled well before the work begins, and job durations are usually based on optimistic job site conditions. During the course of construction, a monthly schedule is broken down to weekly schedules, and weekly schedules are broken down to daily schedules.

Before committing the lead framer to a schedule, the framing contractor normally has agreed to the means and methods that will be followed for the job. If the estimator has based the estimate on a crew that performs differently than an average crew, the schedule may or may not have allowed enough time for the work.

Framer-Friendly Tips

If you're working for a contractor, once you start managing a crew, your own productivity will be measured by theirs.

Planning for Materials

Avoiding Slow-Downs

Once a productive and effective crew has been assembled, nothing can slow that crew down faster than a shortage of material. Construction project estimators and schedulers often look at past project costs for material, labor, and equipment needs and costs. They may make adjustments to these figures based on input from the field, allowing for factors such as a more experienced work force, or new equipment that will make the work go faster. Nevertheless, material shortages can still occur. The lead framer needs to keep an eye on the rate at which materials are being used, and communicate material needs to the superintendent.

Taking Waste into Account

Project estimators perform quantity takeoffs that are really a best guess of how much material will be needed for the job. Waste is a concern in the quantity takeoff for any area of construction. There is some inevitable waste in framing lumber, depending on spans, wall heights, and the grade of lumber. A rule of thumb for lumber waste is 5%–10%, depending on material quality and the complexity of the framing.

Making Sure You Have the Correct Stock

The lead framer should be made aware of any material lists, structural framing drawings, shop drawings, engineered drawings, or cut lists that have been prepared for a framing project. This information is critical to ensure that the correct stock (lengths and widths) is used in the assembly of the frame. Read all notes on the drawings and find out whether the plans being used are the most recently amended or approved version.

Using the plans and shop drawings, the lead framer can determine which material to use for cripples, jacks, headers, blocking, and other miscellaneous members.

"Short" or "Will Call" Deliveries

Keep in mind that many initial stock deliveries are "short," meaning that as the project nears completion, someone is responsible for ordering just enough materials to complete the frame. This is sometimes referred to as "will call." The lead framer needs to know in advance if this strategy is being used.

On some projects where material storage and handling are restricted, a "just-in-time" delivery schedule may be necessary. This means that the lead framer must, in some cases, anticipate material and equipment needs on a daily basis.

In "will call" or "just-in-time" situations, the lead framer must be made aware of any problems in deliveries and must estimate and plan material use in order to maximize the productivity.

How Change Orders Affect the Schedule

A lead framer may be given instructions to perform change orders with little regard for how the change will affect time, cost, and crew productivity.

The time and cost of change order work varies according to how much of the installation has already been completed. Once workers have the project in their mind, even if they have not started, it can be difficult to re-focus. The lead framer may spend more time than usual understanding and explaining the change. Modifications to work in-place, such as trimming and refitting, usually take more time than was initially estimated. Post-installation changes generally involve some demolition. The change may come after finishes and trim are installed and may require protection of in-place work.

When faced with a change or a rework situation, the lead framer must break down the typical day into segments and estimate the impact on each segment. Say a change involves reframing an opening or creating a new opening in a wall that has

been completed. The estimated time for the change should account for demolition, possible salvage of original materials to be reused, procurement of new materials required, and possibly a reluctance of the crew to perform the change. The time spent on the change will generally add time to work in progress. If the lead framer anticipated four openings per day and now has to reframe two, productivity for framing openings may drop to three per day until the change is complete. This will delay setting windows or installing exterior sheathing and other tasks. (See "Changes to the Plans" and "Extra Work" in the next section.)

Recordkeeping

Recordkeeping is quite possibly one of those tasks that you thought you were getting away from when you started framing. The reality is that recordkeeping is an important, but not necessarily major, task for the lead framer. There are three things you will want to keep records for: timekeeping, changes to the plans, and extra work.

Timekeeping

Timekeeping is easy, but you have to record it every day. If you don't, it's easy to forget and make a mistake that is not caught until the payroll checks come out. Most companies provide forms that can be filled out at the end of every day. You will need some type of an organizer to store your time cards and other records. For a small job, an aluminum forms folder, similar to what the UPS drivers use, works well. These folders are durable and keep the rain out. If you are working on a big job, you will probably need something like a builder's attaché to keep all your papers organized. Your time cards can be kept in your organizer so you always know where they are.

Changes to the Plans

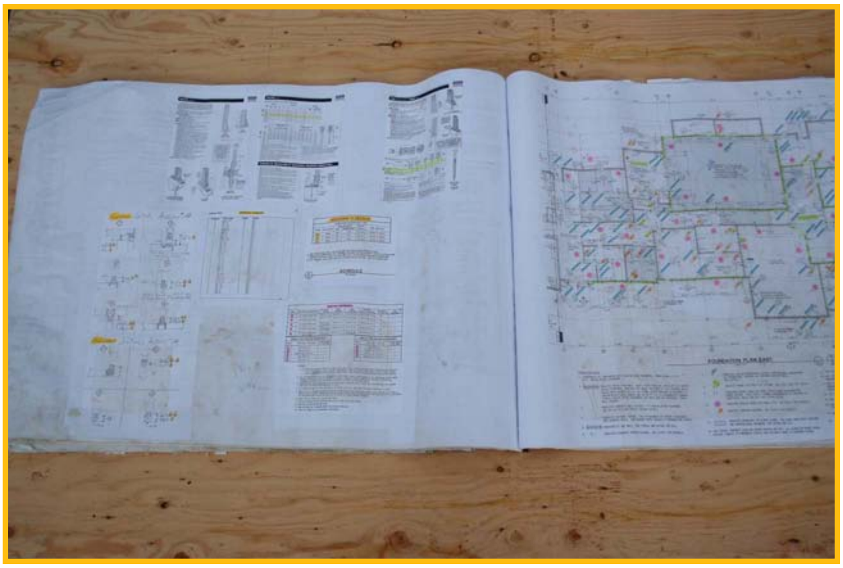
Changes to the plans should always be recorded when they occur. Changes may be conveyed in conversation or in writing. Because the time when you receive the changes is not always the time you will be doing the work, it is important to record the information so that you will not forget it. The best place to record changes is on your plans. Write it on the sheet where you will see it, then write the date and the name of the individual who gave you the change. If it was given to you on paper, keep that document in your organizer after you have written the change on the plans. You can also tape the change to the plans. If there is not enough room to record the changes on the appropriate sheet, tape the information on the back of the prior sheet so you will see it when you are reading the sheet involving the changes.

Keeping your papers organized

Extra Work

The third recordkeeping task is recording change orders. This is important because if work is done that wasn't originally figured in the framing bid or contract, it must be documented in order to obtain payment. This can be a sensitive issue. Many times there is controversy over payment for tasks that are not clearly defined in the bid or contract. If at any time you are asked to perform work that you consider a change order, you should inform the person asking you to do the work right away that this extra work constitutes a change order, and that you expect to be paid for it. The person requesting the extra work can then decide whether they still want to make the change, knowing the extra cost it involves.

When you actually perform the change order work, make sure you record the work done and the cost to be billed. If you are to be paid on a time and material basis, you need to keep accurate time records showing the hour of the day, and the date the work was performed.



Plans with taped changes

Productivity

Your objective is most likely to frame a quality building for the least possible cost. Wages represent the greatest percentage of the total cost, and since wages are paid for time spent working, it follows that if you lessen the time it takes to complete a building, you thereby reduce the wages paid and, thus, lower the total cost.

There are various tasks involved in framing. Some of the tasks can be done as fast, or nearly as fast, by the least experienced framer as by the most experienced framer—for example, carrying and spreading studs. Suppose that a $10/hour person can do the same job as a $20/hour person, only 20% slower. You save $8/hour by having the less expensive person do the job.

Be careful, however, because if an inexperienced framer takes on a job beyond his capabilities, the chances for mistakes are great. This could result in wages paid for work incorrectly done, and higher wages paid for an experienced framer to find and correct the mistake.

It is ideal for you to have a balanced crew of experienced and inexperienced framers. This allows you the flexibility to fit the framer to the task. It takes planning to coordinate framing tasks so that they are done as inexpensively as possible, but it is time well spent for the money you will save.

The following are job titles and responsibilities for a typical large framing crew, divided into four categories: overall organization, walls, floors, and roofs.

Organizing

1) Lead framer

- ☐ Coordinate work schedule with framing or general contractor.
- ☐ Locate lumber drop.
- ☐ Make sure tools and supplies are available.
- ☐ Train framers.
- ☐ Solve problems.

2) Cut and chalk framer

- ☐ Cut stairs and rafters.
- ☐ Chalk lines.
- ☐ Assign framers to tasks.

3) Layout framer

- ☐ Layout for walls, joists, rafters, and trusses.

Walls

1) Plumb and line framer

- ☐ Plumb and line walls.

2) Wall spreader

- ☐ Spread all parts of a wall (studs, trimmers, cripples, headers, etc.) so they are ready to be nailed together.

Typical large framing contractor crew

3) Wall nailer

- ☐ Nail walls together.

4) Makeup framer

- ☐ Nail together a quantity of stud-trimmers, corners, backers, headers, etc., before they are carried to the walls.

Floors

Joisting

1) Rim joister

- ☐ Nail joists in position.
- ☐ Header out joists.

2) Joist nailer

- ☐ Nail joists in position.
- ☐ Nail on joist hangers.
- ☐ Nail blocking and drywall backing.

3) Joist spreader

- ☐ Carry joists into place.

Sheathing

1) Sheathing setter

- ☐ Place and set sheathing.

2) Sheathing nailer

- ☐ Glue joists ahead of setter and nail sheathing behind setter.

3) Sheathing carrier

- ☐ Carry sheathing to setter.

Roofs

1) Spreaders

- ☐ Spread and install trusses and rafters.
- ☐ Install fascia.

2) Blockers

- ☐ Install blocking and drywall backing.
- ☐ Set sheathing.

3) Sheathing packers

- ☐ Carry sheathing to setters.

Typical large framing contractor crew (continued)

Multiple-Framer Tasks

Some tasks require more than one framer, for example, lifting large walls. Any time framers have to be called from other tasks to perform a common task, care must be taken not to waste time. The cost per minute of a 5-framer task is 5 times that of a single framer task. The person organizing the task needs to take responsibility for making sure the task is ready for all framers. If it is lifting a wall, the organizing framer should make sure the wall is completely ready so framers don't stand around while one person makes last-minute adjustments.

Learning Curve

Studies have been done that show that as output is doubled, the time required decreases according to a constant ratio. The common ratio is about 4 to 5, or 20%. For example, the fourth set of stairs built will take 20% less time than the second.

Multiple Cutting Analysis

Multiple cutting becomes efficient when you have to cut a number of pieces of lumber the same size. Trimmers, cripples, and blocks are good examples.

To multiple cut, first spread all the lumber to be cut out on the floor or a table. Then measure each piece, mark each piece with your square, and finally cut each piece.

Analysis has shown it takes 36% less time to cut ten pieces of 2 × 4 when the tasks of spreading, then measuring, then marking, and then cutting are done for all the pieces at one time.

For very large numbers of cuts it may be worthwhile to make a template or a measuring/cutting jig.

Motion Analysis

Question: Can significant time (and money) be saved by moving faster?

Answer: Motion analysis studies have shown that something as simple as walking more quickly around the site can substantially raise productivity. For instance, if a framer spends 2 hours in an 8-hour day walking from point to point on a job site, a quick walk can save about 30 minutes per day over a relaxed walk.

Speed Versus Quality

Speed or quality: Which should it be? How good must the work be if it must be done as fast as possible? The two variables to consider when answering these questions are:

- Strength
- Attractiveness

First and most important is the structural integrity of the building. The second is creating a finished frame that will be pleasing to the eye. Once requirements for strength and attractiveness are satisfied, the faster the job can be done, the better.

Material Movement

Framing requires a lot of material movement. It is estimated that one-quarter to one-third of a framer's time is spent moving material, so any time or energy saved is a cost reduction.

The following hints will help you save time, energy, motion and, in the last analysis, money.

- Whenever material is lifted or moved, it takes time and energy; therefore, move material as little as possible.

- When stacking lumber, consider the following:
  —Where will it be used next?
  —Will it be close to where it is going to be used?
  —Will it be in the way of another operation?
  —Will it obstruct a pathway?
- Always stack material neatly. This helps to keep the lumber straight and makes it easy for framers to pick up and carry it. Stack 2 × 4 studs in piles of eight for a convenient armful.
- Have second-floor lumber dumped close to the building so framers can stand on the lumber stack and throw it onto the second floor.
- When stacking lumber on a deck, place it where walls will not be built, so it will not have to be moved again.
- Use mechanical aids, such as levers, for lifting. Remember your physics—the longer the handle in relation to the lifting arm, the easier it will be to lift the load.
- Two trips to the lumber stack or tool truck cost twice as much as one trip. If you have to go to the tool truck for a tool, check to see if you need nails or anything else.

Framer-Friendly Tips

Pieces of pipe come in handy for rolling stacks of lumber. On bigger jobs with forklifts, use pallets for collecting and moving material, such as multiple blocks.

Tool Maintenance Schedule

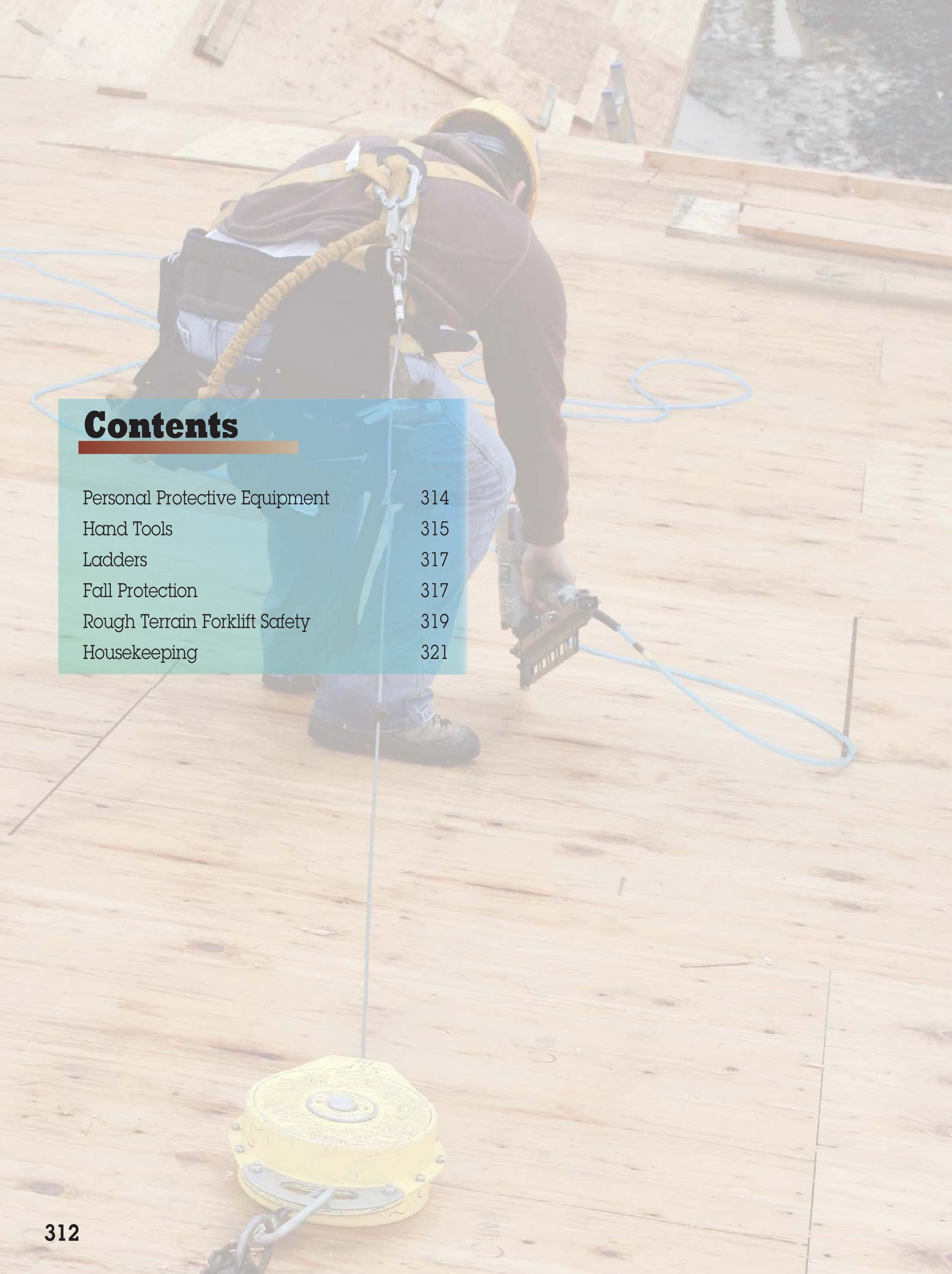
Draw up a schedule such as the one shown in the following table for your specific equipment; post it, and assign a reliable crew member to take charge of it.

Equipment	Schedule	Maintenance Operation	Lubrication
Worm-drive saw	First of every month	Check oil	Heavy-duty saw lubricant
Nail guns	Each day before using	Oil	Gun oil
Compressors	Before using every day	Check oil	30-weight non-detergent
	Every Friday	Empty air and drain tanks	
	First of each month	Check air-intake filter	
	Every month	Change oil	30-weight non-detergent
Electric cords	First of each month	Test cords color code	

Conclusion

When you started reading this chapter, you were probably hoping for some nice clean answers on how to manage a crew—answers that you could put to use tomorrow. Now you are probably thinking that you have more questions than you did when you started reading—and that's the way it should be. Managing a crew is a never-ending job that will challenge you every day. The information presented in this chapter should give you a base for the common-sense decisions you will have to continually make in response to the questions that come up as you manage your crew.

Chapter Fifteen
SAFETY



Contents

Personal Protective Equipment 314

Hand Tools 315

Ladders 317

Fall Protection 317

Rough Terrain Forklift Safety 319

Housekeeping 321

Chapter Fifteen

SAFETY

If you have been framing long enough to understand advanced techniques or to be considering a career as a lead framer, you have probably seen enough accidents to make you aware of the importance of safety. Common sense will help guide you in knowing what is safe and what is not, but you must also be aware of the potential dangers. This information is usually acquired from the lead framer who taught you, from apprenticeship classes, and from weekly safety meetings, as well as state and federal regulations for the job site.

The safety topics presented in this chapter are not intended to be a complete list, but rather to cover the items you will come in contact with or have questions about most often.

Personal Protective Equipment

What we wear can either help prevent accidents or help cause them. Think about what you are going to do during the day, and prepare for it. It's a good idea to discuss personal protective equipment needed for specific tasks at your safety meetings. Keep an eye on new framers so you can detect any potential safety problems.

Hard hats are the symbol of the construction industry. Some jobs require that hard hats be worn. The Occupational Safety and Health Administration (OSHA) says that a hard hat needs to be worn if there is a possible danger of head injury from impact, or from falling or flying objects.

Eye protection is required by OSHA when there is a reasonable probability of preventable injury when equipment such as a nail gun is used. Eye protection can be provided by safety glasses. Safety glasses can be found that are lightweight and also look good. They should always be worn when using power saws.

Safety glasses

Ear protection is recommended when you are exposed to high levels of noise. High noise levels can cause hearing impairment and hearing loss, as well as physical and psychological stress. There is no cure for hearing loss caused by exposure to noise. Framers are exposed to these high levels at various times, not so much from their own work as from surrounding operations. The easiest way to protect yourself from hearing impairment is to keep disposable earplugs handy. They are easy to use and once they are in, you barely notice them.

Foot protection can be provided by a pair of leather work shoes or boots with hard soles. The boots will help protect your ankles. Steel toes provide extra protection for your toes and can be useful as support for lumber you are cutting. Rubber boots are good in wet weather and provide an extra measure to prevent electric shock.

Pants and shirts should be fit for work. If they are too loose, there is the chance they can get caught in something like a saw or a drill and pull you into the drill bit, which might throw you off a ladder. If your pants are too loose or frayed at the bottoms, they can cause you to trip and fall. Be careful with other clothing, such as belts and coats, so that they don't hang loose and get caught.

"Oh, my aching back." Everybody has heard those words. In fact, back injuries are the most common type of injury in the workplace. Framing is lifting-intensive work—so measures to prevent back injuries deserve your attention. Stretching each morning and strengthening exercises are good for your back, but more important is making sure you lift properly. (See "Proper Lifting" photo.) Make it a point to use your legs to lift, and not your back. When you are lifting walls, remind your crew to lift with their legs. When picking something up, bend your knees and keep your back straight. When carrying, keep objects close to your body, and avoid twisting and jerky motions.

Hand Tools

Nail guns are one of a framer's most commonly used tools. They are also one of the most dangerous. Most framers can show you a scar from having shot themselves with a nail gun. Fortunately, many of these injuries are not serious. However, there have been instances where serious injury or death has occurred. Following are some very basic guidelines that will help you operate a nail gun safely. (Always familiarize yourself with the manufacturer's complete operating instructions.)

- Wear safety glasses.
- Do not hold the trigger down unless you're nailing.
- Be careful when nailing close to the edge. The push lever at the nose of the gun can catch the wood and allow the gun to fire without the nail hitting the wood, allowing the nail to fly toward whatever is in line with the gun.
- Always keep your hand far enough away from the nose of the nail gun so that if the nail hits a knot or obstruction and bends, it will not hit your hand.
- Never point a nail gun at anyone.
- Disconnect the air hose before working on the gun.
- Use a gun hanger when working at heights, or secure your air hose so the gun does not get dragged off or fall. (See "Nail Gun and Hanger" photo.)
- When nailing off the roof or high floor sheathing, move in a forward, not a backward direction to prevent backing off the edge.
- Move from top to bottom on wall sheathing so you can use the weight of the gun to your advantage.

Trainees are the most vulnerable to nail gun accidents. Make sure that when you are training new recruits on nailing with a nail gun, you formally instruct them on nail gun safety and the potential for accidents.

Circular saws have cut off many fingers. A healthy respect for them is the first step toward safety. Follow these basic guidelines (and the manufacturer's operating instructions):

- Wear safety glasses when operating a circular saw.
- Always keep your fingers away from where the blade is going.
- Never remove or pin back the guard on the saw. The saw guard has a tendency to catch on many cuts, especially angle cuts, which makes it tempting to pin the guard back. Aside from the fact that it is an OSHA violation, a saw can become bound in a piece of wood, and "kick back." If the guard is pinned back, this can result in serious injury such as cuts to the thigh.

Proper lifting

- Never use a dull blade. It will cause you to put excess directional force on the saw, which could cause it to go where you don't want it to.
- Disconnect from power if you are working on the saw.
- When you are cutting lumber, make sure that one end can fall free so that the blade does not bind and kick back.

As the teeth of a circular saw speed around at almost 140 miles per hour, it becomes very dangerous if not used properly.

Miscellaneous hand tools also need to be used properly for safety. The following guidelines apply to many hand tools:

- Make sure all safety guards are in place.
- Keep your finger off the trigger of power tools when you are carrying them to prevent accidental starting.

Nail gun and hanger

- Keep tools properly sharpened.
- Store tools in the locations provided.
- Before working on power tools, unplug them or take out the battery.
- Replace worn or broken tools immediately.
- Never leave tools in paths where they can become a tripping hazard.

To use a **powder-actuated tool**, you need to be trained by a certified trainer. Following are some of the basics that you will learn:

- You must wear safety glasses.
- Hard hats and hearing protection are recommended.
- Never point a powder-actuated nail gun at anyone.
- Before you fire, make sure no one is on the other side of the material you are firing into.
- Do not load the firing cartridge until you are ready to use it.
- If there is a misfire, hold the tool against the work surface for at least 30 seconds; then try firing again. If the tool misfires a second time, hold it against the work surface again for 30 seconds; then remove the cartridge and inspect the gun. Soak the misfired cartridges in water in a safe location.
- Powder-actuated tools need to be placed firmly against the work, perpendicular to the work to avoid ricochet.

It's also a good idea to say "fire" just before you pull the trigger, so the shot noise will not startle the workers around you.

Ladder extension

Ladders

Inappropriate use of ladders is the number one cause of falls. Ladders are used so often in framing that it is easy to overlook basic safety guidelines. Always remember the following:

- The feet of the ladder need to be on a stable surface so the ladder will be level.
- When ladders are used to access an upper surface, make sure they extend at least three feet above the upper surface, and secure the top to prevent them from being knocked over. (See "Ladder Extension" photo.)
- Do not use the top or top step of a step ladder.
- For straight or extension ladders, remember the 4 to 1 rule. For every four feet of height the ladder extends, it needs to be placed one foot out at the base.
- Check the ladder for defective parts, and remove any oil or grease on the steps.
- Never leave tools on the top step of a ladder.

Use common sense. If you are not sure that a ladder is safe, don't use it.

Fall Protection

OSHA provides that for unprotected sides and edges on walking or working surfaces, or for leading edges of six feet or more, framers must be protected from falls by the use of a guardrail system, a safety net system, or a personal fall arrest system. For leading edge work, if it can be demonstrated that these systems are not feasible or they create a greater hazard, then a plan may be developed and implemented to meet certain OSHA requirements.

Most deaths in the construction industry happen as a result of falls. Falls also cause many of the injuries that occur on the job site, according to OSHA.

Because framing can place you a story or more off the ground, it's important to work safely and to become aware of fall protection equipment, as well as systems (such as guardrails, safety nets, and covers) that can help prevent falls.

The following sections cover safety tips on equipment and systems. Using these can help protect yourself and others on the job site from falls.

The most commonly used fall protection systems in framing are the *personal fall arrest system* and the *guardrail system*. The guardrail system works well for a large flat deck. The fall arrest is better suited for pitched roofs.

Guardrails

Metal guardrail supports can be nailed to the outside of walls to support 2 × 4 railings. However, it is more common to see railing made out of 2 × 4 for the support and railings. These railings can be nailed on before the walls are raised. Following are some OSHA regulations on guardrails:

- The top edge of the top rail must be at least 42" (plus or minus 3") above the working level.
- Mid-rails must be installed at a height midway between the top edge of the top rail and the working level.
- The top edge of the guardrail system must be able to withstand 200 pounds applied within two square feet in an outward or downward direction.
- The mid-rail must be able to withstand at least 150 pounds in an outward or downward direction.
- When access is provided in the guardrail system, a chain, gate, or removable guardrail sections should be placed across the opening when loading operations are not taking place.

Fall arrest system

Personal Fall Arrest Systems

These systems typically consist of a full body harness, a lanyard, a lifeline, and an anchor. (See "Fall Arrest System" photo.) Each of these parts is available in many different types. Some of the OSHA regulations for these systems are listed below.

- D-rings, snaphooks, and carabiners must have a minimum tensile strength of 5,000 pounds.
- Lanyards and vertical lifelines must have a minimum breaking strength of 5,000 pounds.
- Anchors must be capable of supporting at least 5,000 pounds per framer.
- The system must be rigged so that the framer cannot free-fall more than 6 feet.
- The attachment point for a body harness is to be located in the center of the wearer's back near the shoulder level or above the wearer's head.

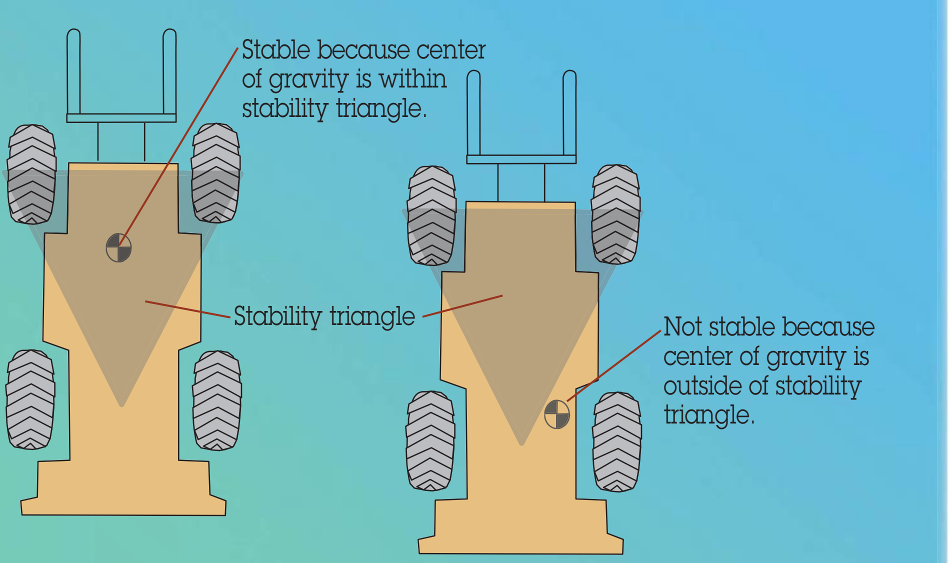
If you have new framers who are not used to working with fall arrest systems, you will need to spend some time with them to help them become familiar and comfortable with this equipment.

Rough Terrain Forklift Safety

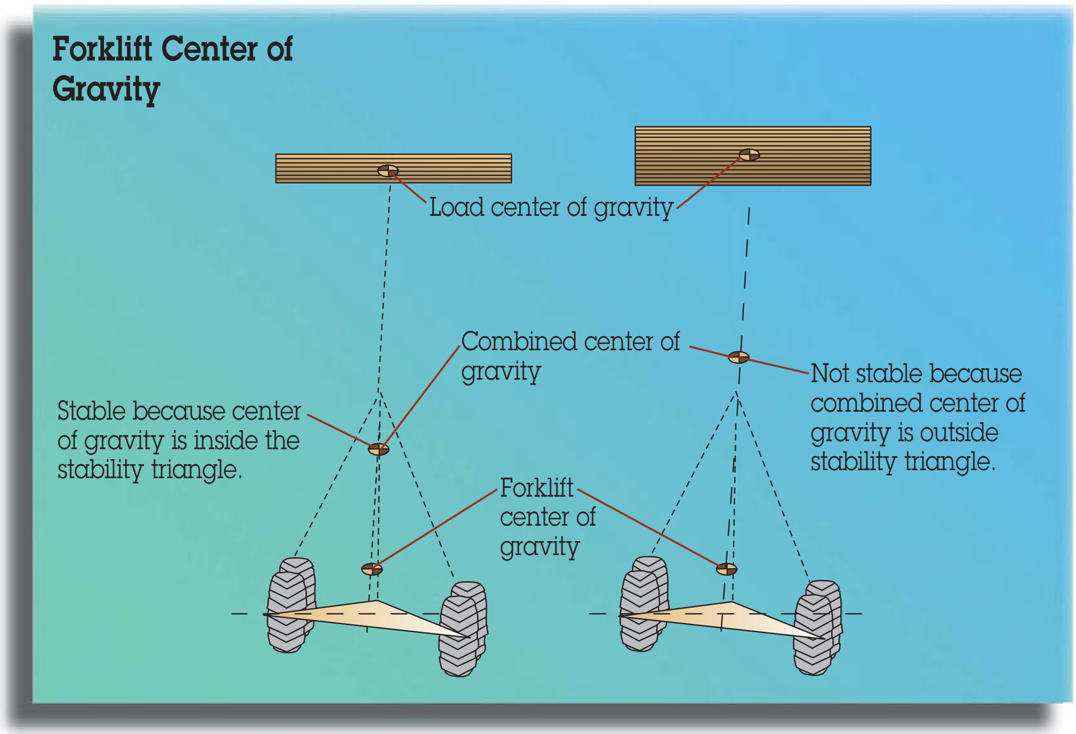
To operate a forklift, you need to be certified. To obtain certification, you need to be trained and actually operate a forklift. The points below are intended as a refresher for those who are already certified, and as an introduction to those intending to be certified.

- It is the weight of the forklift and the position of the tires that keep a forklift from turning over. There is an imaginary triangle between the front two tires and the space between the back two tires. This is called the *stability triangle*. The center of gravity for the forklift lies within this triangle. As the forks with weight extend out, the center of gravity moves. If the center of gravity goes outside the stability triangle, the forklift will tip. Getting the feel for the location of the center of gravity and the stability triangle is important to safe operation before you start working with a forklift. A good way to start is to lift a load of lumber and extend it out next to the ground until the back wheels start to come off the ground.
- The center of gravity is also changed when the forklift is on sloped ground. The situation is exaggerated greatly if there is a load on the forks and they are extended. (See "Forklift Center of Gravity" illustrations.)
- If you are using a forklift and it starts to tip over, stay in the seat; do not jump out of the forklift.
- Before you operate any machine, be sure you are familiar with all the controls.
- Before you operate the forklift, do an inspection. Walk around the forklift checking for anything that does not look right, such as leaking fluids. Then get in the cab, start the engine, and check the gages and other controls.
- Never leave the forklift while the engine is running.
- Know the forklift hand signals. (See "Forklift Hand Signals" illustration.)

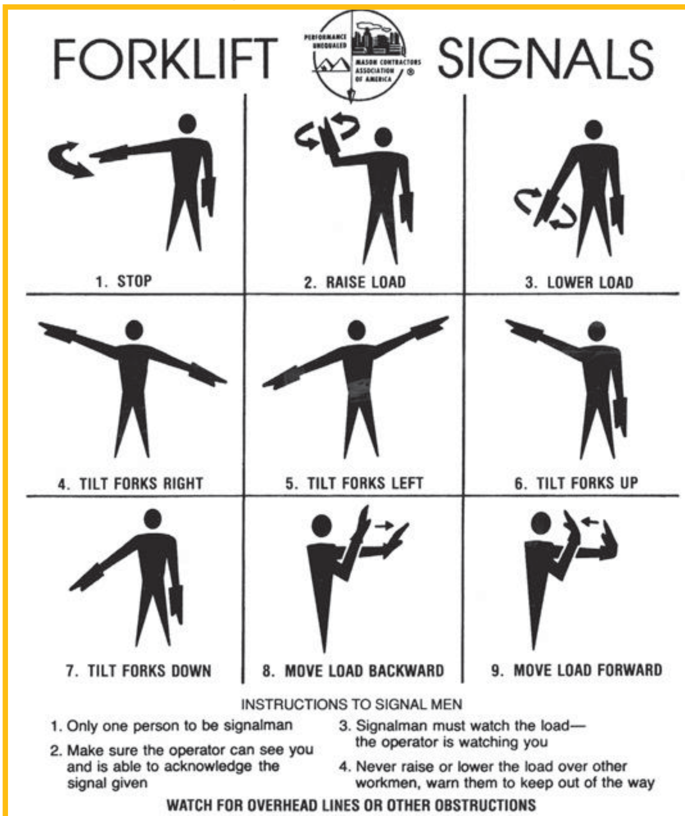
Forklift Center of Gravity



Forklift Center of Gravity



Forklift Hand Signals



Source: Mason Contractor's Association of America

- Keep the forks close to the ground with or without a load.
- Always be looking for obstacles in your way like power lines overhead.
- Check the forklift load chart to make certain the forklift can handle the load you intend to move. The load capacity of a vehicle can be found on the identification plate and in the operator's manual. (See "Load Chart" photo.)

A forklift is a very big and heavy piece of machinery, capable of doing a great amount of damage. Make sure you treat it with respect.

Load chart

Crane or Boom Truck Safety

When working with a crane or boom truck, the most important thing for a framer is to have good communication with the operator. Because you are typically out of audible range, you will need to use hand signals. You should use the industry-accepted standards shown in the "Crane and Boom Truck Hand Signals" illustration.

Housekeeping

Housekeeping is something we all grow up with. Some learn it better than others. On the job site, we all must practice good housekeeping because it affects safety and productivity. There are three main housekeeping issues: job site scraps, personnel debris, and tool organization.

Job site scraps are the cut-off ends of pieces of wood, lumber torn down that will not be used again, wrapping from lumber, empty nail boxes, and numerous other materials brought onto the job site that will not be used. You don't always want to take the time to attend to this debris at the moment it is made, but you do need to make sure that it is not left in a location that would pose a safety problem, such as in a walkway or at the bottom of a ladder. As you create the scraps, throw them in a scrap pile or at least in the direction of a scrap pile. Many cut-off pieces of lumber can be used for blocking and should be thrown in the direction of where they will be mass-cut later.

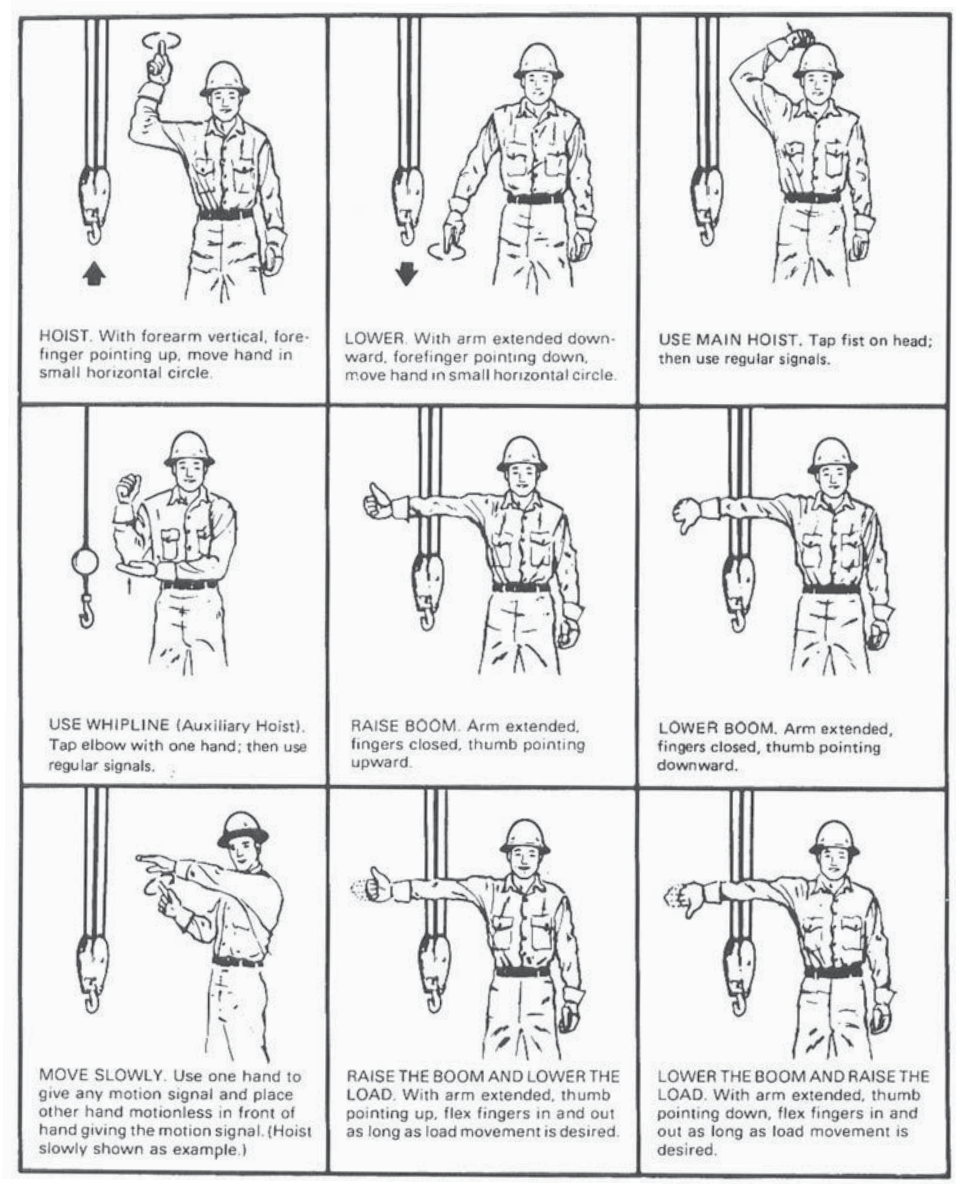
Whenever you have lumber with **nails** sticking out, pull the nails out if you are going to use the lumber again, or bend them if the lumber will be thrown away. It is easy to forget this, so be sure to attend to the nails while you are working with them and they are on your mind.

Personnel debris is the garbage individuals create personally, like lunch scraps and soda bottles. It makes it easier on your crew if you provide some sort of container near the lunch spot. You will be lucky if you don't have to keep reminding your crew that they are responsible for their own personal garbage.

Tool organization can save you time and a lot of aggravation. With tools that are in common use by the crew, it is important to return the tool to where it belongs. If tools are not stored in a location where other framers can expect them to be, a lot of time will be wasted looking for them. When rolling out your electric cords and air hoses, keep them organized. If you have to roll out in a walkway, try to stay to one side or the other. If you have to move your hose or cord, and it is rolled out underneath someone else's cord or hose, be careful that when you move yours, you don't drag theirs (and possibly their tools) along with you.

Housekeeping is sometimes difficult to organize, but getting it right can be a big asset for safety and productivity.

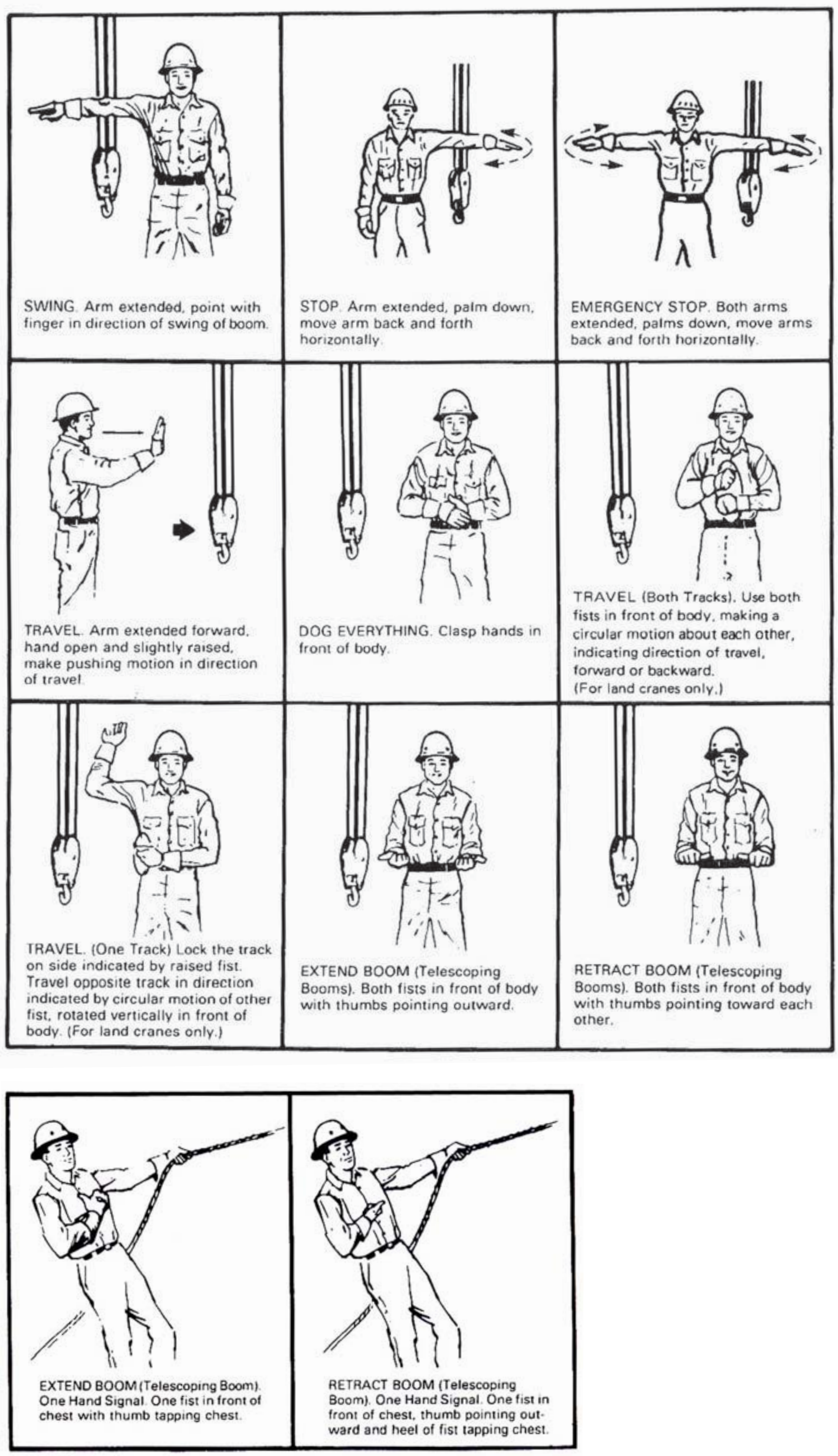
Mobile Crane and Boom Truck Hand Signals



Framer-Friendly Tips

One framer should be appointed to direct the crane, and no one else should give directions.

Mobile Crane and Boom Truck Hand Signals *(continued)*



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Safety Tips

These safety tips provide a quick summary of basic safety concerns.

1. Keep your work area neat underfoot, especially main pathways.
2. Keep work areas well lighted and adequately ventilated.
3. Don't leave nails sticking out; pull them or bend them over.
4. When lifting, always lift using your leg muscles and not your back. Always keep your back straight, your chin tucked in, and your stomach pulled in. Don't carry objects resting against your stomach; this will cause your spine to bend backward. Maintain the same posture when setting objects down.
5. When working on joists, trusses, or rafters, always watch each step to see that what you are stepping on is secure.
6. Never pin circular saw guards back.
7. Do not wear loose or torn clothing that can get caught in tools.
8. Wear heavy shoes or boots that help protect your feet against injury.
9. Wear hard hats where material or tools can fall on your head.
10. Wear safety glasses where there is any potential for injury to the eye.
11. Use hearing protection when operating loud machinery or when hammering in a small, enclosed space.
12. Wear a dust mask for protection from sawdust, insulation fibers, or the like.
13. Use a respirator whenever working in exposure to toxic fumes.
14. Assign a qualified person to regularly inspect the job site.
15. Make first aid supplies available and make sure they are replenished on a regular basis.
16. Post location and number of the closest medical facility.
17. Always secure ladders before using.
18. When exposed to a fall hazard, always wear a personal fall arrest system.

Conclusion

The safety topics in this chapter are just a small part of a total safety plan, but represent a good base. Remember, as a lead framer, you can't afford to forget about your own safety, not only for your own well-being, but because your framers will look to you to see how seriously you take it. It's easy to forget safety measures when you are in a rush on a job, but when you stop and think about it, the alternatives could be losing a finger or even risking death. It's not hard to see the importance of safety. With a little bit of effort, your jobs can be safe and productive.

GLOSSARY, SPANISH FRAMING TERMS, & INDEX

GLOSSARY

anchor bolt
A bolt for connecting wood members to concrete or masonry.

backer
Three studs nailed together in a U-shape to which a partition is attached.

bargeboard
A board attached to a gable rafter to which a rake board is attached.

beam
A large, horizontal structural member of wood or steel, such as a girder, rafter, or purlin.

bearing wall
A wall that supports the load of the structure above it.

bevel
Any angle that is not 90°. Also, a tool for marking such an angle.

bird's mouth
The notch in a rafter that rests on the top plate of a wall.

blocking
Small pieces of wood used to secure, join, or reinforce members, or to fill spaces between members.

box nail
Nail similar to a common nail, but with a smaller diameter shank.

bridging
Bracing installed in an X-shape between floor joists to stiffen the floor and distribute live loads. Also called cross-bridging.

building line
The bottom measurement of a rafter's run (the top being the ridge line); the plumb cut of the bird's mouth.

camber
A slight crown or arch in a horizontal structural member, such as beam or truss, to compensate for deflection under a load.

cantilever
Any part of a structure that projects beyond its main support and is balanced on it.

cant strip
A length of lumber with a triangular cross-section used around edges of roofs or decks to help waterproof.

casing
A piece of wood or metal trim that finishes off the frame of a door or window.

casing nail
A large finish nail with a small, cone-shaped head.

chalk line
A string covered with chalk used for marking straight lines.

check
A small split in a piece of lumber that runs parallel to the grain.

cheek cut (side cut)
An angle cut that is made to bear against another rafter, hip, or valley.

chord
Any principal member of a truss system. In a roof truss, the top chord replaces a rafter, and the bottom chord replaces a ceiling joist.

circumference
The perimeter measurement of a circle.

collar beam
A horizontal board that connects pairs of rafters on opposite roof slopes.

column
A vertical structural member.

common nail
Nail used in framing and rough carpentry, having a flat head about twice the diameter of its shank.

common rafter
A rafter running from a wall directly to a ridge board.

connection angle
The angle at the end of a rafter needed to connect to other rafters, hips, valleys, or ridge boards.

connectors
Beams, or construction hardware specifically designed for common framing connections.

corner
Two studs nailed together in an L-shape, used to attach two walls and provide drywall backing.

cornice
The horizontal projection of a roof overhang at the eaves, consisting of lookout, soffit, and fascia.

crawl space
The area bounded by foundation walls, first-floor joists, and the ground in a house with no basement.

cricket
A small, sloping structure built on a roof to divert water, usually away from a chimney. Also called a saddle.

cripple
A short stud installed above or below a horizontal member in a wall opening.

cripple jack rafter
A rafter that runs between a hip rafter and a valley rafter.

crown
The high point of a piece of lumber that has a curve in it.

cup
Warp across the grain.

d
Abbreviation for penny (nail size). The abbreviation comes from the Roman word denarius, meaning coin, which the English adapted to penny. It originally referred to the cost of a specific nail per 100. Today it refers only to nail size.

dead load
The weight of a building's construction materials, in place, in pounds per square foot. This includes walls, floors, roofs, ceilings, stairways, finishes, HVAC and plumbing systems, and other architectural and structural items and building systems.

diagonal
The distance between the far point on the run and the high point on the rise. (Similar to hypotenuse in mathematical terms.)

diagonal percent
The diagonal divided by the run, used when cutting rafters.

dormer
A structure with its own roof projecting from a sloping roof, typically to accommodate a vertical window.

double cheek cut
A two-sided cut that forms a V at the end of some rafters, especially in hip and gambrel roofs.

dry line
A string line (as opposed to a chalk line) used to establish a straight line.

eave
The part of a roof that projects beyond its supporting walls.

engineered wood products (EWP)
Building framing, joists, and beams made from wood strands or fibers held together with a binder.

face-mount hangers
Hangers that nail onto the face or vertical surfaces of their supporting members.

face nailing
Nailing at right angles to the surface.

fascia
A vertical board nailed to the lower ends of rafters that form part of a cornice.

fireblock
A short piece of framing lumber nailed horizontally between joists or studs to partially block the flow of air and, thus, to slow the spread of fire.

footings
The base, usually poured concrete, on which the foundation wall is built. The footing and foundation wall are often formed and poured as a single unit. It spreads and transmits the load directly to the soil.

footprint
The area that falls directly beneath and shares the same perimeter as a structure.

form
A mold of metal or wood used to shape concrete until it has set.

foundation
The building's structural support below the first-floor construction. It rests on the footing, and transfers the weight of the building to the soil.

frame
The skeleton of a building. Also called framing.

framer
A person who performs rough carpentry, building the frame of the structure to which sheathing and finish treatments will be attached.

framing anchor
A metal device for connecting wood framing members that meet at right angles.

framing point
The point where the center lines of connecting rafters, ridges, hips, or valleys meet.

furring
Strips of wood fastened across studs or joists to a level or plumb nailing surface for finish wall or ceiling material, usually drywall. Also called strapping.

gable
The triangular part of an end wall between the eaves and ridge of a house with a peaked roof.

gable roof
A roof shape characterized by two sections of roof of constant slope that meet at a ridge; peaked roof.

gambrel roof
A roof shape similar to a gable roof, but with two sections of roof on each side of the ridge, the lower section being steeper than the upper.

girder
A primary horizontal beam of steel or wood used to support other structural members at isolated points along its length.

glu-lam beams
Structural beams created by gluing 2× dimensional lumber together in a structurally ordered pattern.

grade
1. A designation of quality, especially of lumber and plywood.

2. Ground level. Also the slope of the ground on a building site.

gusset
A flat piece of plywood or metal attached to each side of two framing members to tie them together, or strengthen a joint.

gusset plates
Plates fastened across a joint that can be used to replace a ridge board.

header
Any structural wood member used across the ends of an opening to support the cut ends of shortened framing members in a floor, wall, or roof.

hip
The outside angle where two adjacent sections of roof meet at a diagonal. The opposite of a valley.

hip diagonal (or valley diagonal)
The distance between the far point on the hip or valley run and the high point on the hip or valley rise.

hip rafter
The diagonal rafter, which forms a hip.

hip roof
A roof shape characterized by four or more sections of constant slope, all of which run from a uniform eave height to the ridge.

hip run (or valley run)
The horizontal distance below the hip or valley of a roof, from the outside corner of the wall to the center framing point.

hip-val diagonal percent
The hip or valley diagonal divided by the hip or valley run.

hold-downs
Connections used to transfer tension loads between floors. Commonly used for foundations, wall-to-wall connections, wall-to-concrete connections, and wall or floor-to-drag strut. Also called anchor downs or tie-downs.

I-joist
An engineered wood product created with two flanges joined by a web and that develops certain structural capabilities. I-joists are also used for rafters.

***International Building Code* (IBC)**
The building code established in 2000 by the International Code Council (ICC) to cover all buildings other than one- and two-family dwellings and multiple single-family dwellings not more than three stories in height.

***International Residential Code* (IRC)**
The International Code Council's (ICC) building code that covers all one- and two-family dwellings and multiple single-family dwellings not more than three stories in height.

jack rafter
A short rafter, usually running between a top plate and a hip rafter, or between a ridge and a valley rafter.

jack stud
A shortened stud supporting the header above a door or window. Also called a trimmer or jamb stud.

jamb
The side of a window or door opening.

joint
The line along which two pieces of material meet.

joist
One of a parallel series of structural members used for supporting a floor or ceiling. Joists are supported by walls, beams, or girders.

joist hanger
A metal framing anchor for holding joists in position against a rim joist, header, or beam.

kerf
The cut made by a saw blade.

king stud
A vertical support member that extends from the bottom to top plate alongside an opening for a door or window.

kneewall
A short wall under a slope, usually in attic space.

layout language
The written words and symbols the lead framer uses to communicate directions for framing work.

lead framer
Foreman or leader of a framing crew.

ledger
A strip of lumber attached to the side of a girder near its bottom edge to support joists. Also, any similar supporting strip.

level
Perfectly horizontal. Also refers to various types of measuring instruments used to determine horizontal or vertical alignments.

lightweight plate
A plate that goes under the bottom plate to raise walls for lightweight concrete or gypcrete.

live load
The total variable weight in pounds per square foot on a structure including occupants, furnishings, snow, and wind.

load path
The path taken by artificial and natural forces that affect a building when they create a load exerted on the building.

lookout
A horizontal framing member attached to a rafter, supporting an overhanging portion of the roof.

lumber
Wood cut at a sawmill into usable form.

makeup
Parts of a wall (such as backers, corners, headers, and stud trimmers) cut before the wall is spread.

mansard roof
A type of roof with two slopes on each of four sides, the lower slope much steeper than the upper and ending at a constant eave height.

mortise
A recess cut into wood.

mudsill
The lowest plate in a frame wall that rests on the foundation or slab.

nail gun
A hand-operated tool powered by compressed air that drives nails.

nominal size
The rounded-off, simplified dimensional name given to lumber. For example, a piece of lumber whose actual size is 1½" × 3 ½" is given the more convenient, nominal designation of 2" × 4".

nonbearing wall
A dividing wall that is not designed to support the load of any structure above it.

nosing
The rounded front edge of a stair tread that extends over the riser.

on center (O.C.)
Layout spacing designation that refers to the distance from the center of one framing member to the center of another.

oriented strand board (OSB)
Wood made out of flakes, strands, or wafers sliced from small wood logs bonded under heat with a waterproof and boil-proof resin binder.

overhang
The part of a roof that extends beyond supporting walls.

overhang diagonal
The distance between the far point on the overhang run and the high point on the overhang rise.

overhang hip run
The horizontal distance below the hip or valley of a roof, from the outside corner of the wall to the center framing point.

parallel
Extending in the same direction and equidistant at all points.

parapet
A low wall or rail at the edge of a balcony or roof.

particleboard
Engineered lumber made of wood particles bonded by an adhesive under a heat and pressure, and formed into a solid, three-layered panel with two surface layers. (Usually used as an underlayment.)

partition
An interior wall that divides a building into rooms or areas.

party wall
A wall between two adjoining living quarters in a multi-family dwelling.

penny
Word applied to nails to indicate size; abbreviated as "d."

perpendicular
At right angles to a plane or flat surface.

pitch
The slope of a roof.

pitch angle
The vertical angle on the end of a rafter that represents the pitch of a roof.

plate
A horizontal framing member laid flat.

> **bottom plate**
> The lowest plate in a wall in the platform framing system, resting on the subfloor, to which the lower ends of studs are nailed.
>
> **double plate**
> The uppermost plate in a frame wall that has two plates at the top. Also called a cap or rafter plate.
>
> **sill plate**
> The structural member, attached to the top of the foundation, that supports the floor structure. Also called a sill or mudsill.
>
> **top plate**
> The framing member nailed across the upper ends of studs and beneath the double plate.

platform framing
A method of construction in which wall framing is built on and attached to a finished box sill. Joists and studs are not fastened together as in balloon and braced framing.

plumb
Straight up and down, perfectly vertical.

plumb and line
The process of straightening all the walls so they are vertical and straight from end to end.

plumb cut
Any cut in a piece of lumber, such as at the upper end of a common rafter, that will be plumb when the piece is in its final position.

purlin
The horizontal framing members in a gambrel roof between upper and lower rafters.

Pythagorean theorem
The theorem that the sum of the squares of the lengths of the sides of a right triangle is equal to the square of the length of the hypotenuse.

rabbet
A groove cut in or near the edge of a piece of lumber to receive the edge of another piece.

rafter
One of a series of main structural members that form a roof.

rake
The finish wood member running parallel to the roof slope at the gable end.

rake wall
Also called gable end walls. Any wall that is built with a slope.

reveal
The surface left exposed when one board is fastened over another; the edge of the upper set slightly back from the edge of the lower.

ridge
The horizontal board to which the top ends of rafters are attached.

ridge end rafter
A rafter that runs from the end of a ridge.

rim joist
A joist that forms the perimeter of a floor framing system.

rise
1. In a roof, the vertical distance between the top of the double plate and the point where a line, drawn through the edge of the double plate and parallel to the roof's slope, intersects the center line of the ridgeboard.

2. In a stairway, the vertical height of the entire stairway measured from floor to floor.

riser
The vertical board between two stair treads.

roof sheathing
Material, usually plywood, laid flat on roof trusses or rafters to form the roof.

rough opening (R.O.)
Any opening formed by the framing members to accommodate doors or windows.

rout
To cut out by gouging.

run
1. In a roof with a ridge, the horizontal distance between the edge of the rafter plate (building line) and the center line of the ridge board.

2. In a stairway, the horizontal distance between the top and bottom risers plus the width of one tread.

scaffold
The covering (usually wood boards, plywood, or wallboards) placed over exterior studding or rafters of a building; provides a base for the application of exterior wall or roof cladding. Any temporary working platform and the structure to support it.

scribe
To mark for an irregular cut.

seat cut
The horizontal cut in a bird's-mouth that rests on the double plate.

shear wall
A wall that, in its own plane, carries shear resulting from forces such as wind, blast, or earthquake.

sheathing
Material, usually plywood, attached to studs to form the outside wall and provide structural strength.

shed roof
A roof that slopes in only one direction.

shim
A thin piece of material, often tapered (such as a wood shingle) inserted between building materials for the purpose of straightening or making their surfaces flush at a joint.

sill
1. A sill plate.

2. The structural member forming the bottom of a rough opening for a door or window. Also, the bottom member of a door or window frame.

single cheek cut
A bevel cut at the end of a rafter, especially in hip and gambrel roofs.

sleeper
Lumber placed on a concrete floor as a nailing base for wood flooring.

slope
The pitch of a roof, expressed as inches of rise per twelve inches of run.

soffit
The underside of a projection, such as a cornice.

solid bridging
Blocking between joists cut from the same lumber as the joists themselves and used to stiffen the floor.

spacer
Any piece of material used to maintain a permanent space between two members.

span
The distance between structural supports, measured horizontally (typically from the outside of two bearing walls).

speed square
A triangle-shaped tool used for marking perpendicular and angled lines.

square
1. At 90°, or a right angle.

2. The process of marking and cutting at a right angle.

3. Any of several tools for marking at right angles and for laying out structural members for cutting or positioning.

4. A measure of roofing and some siding materials equal to 100 square feet of coverage.

squash blocks
A structural block used to support point loads.

stair
A single step or a series of steps or flights of steps connected by landings, used for passage from one level to the next.

stair nuts
Two screw clamps that are attached to a framing square for marking stair stringers.

stair stringer
An inclined board which supports the end of the treads. Also known as stair jacks.

stairway
A flight of stairs, made up of stringers, risers, and treads.

stairwell
The opening in a floor for a stairway.

stickers
Strips of scrap wood used to create an air space between layers of lumber.

stick frame
Method of framing involving building one structural member at a time, e.g. nailing one stud at a time in place.

stop
In general, any device or member that prevents movement.

story pole
A length of wood marked off and used for repetitive layout or to accurately transfer measurements.

stringer
In stairway construction, the diagonal member that supports treads and to which risers are attached.

structural
Adjective generally synonymous with "framing."

stud
The main vertical framing member in a wall to which finish material or other covering is attached.

subfloor sheathing
The rough floor, usually plywood, laid across floor joists and under finish flooring.

tail
The part of a rafter that extends beyond the double plate.

tail joist
A shortened joist that butts against a header.

tape
A measure of coiled, flexible steel.

template
A full-sized pattern.

threshold
The framing member at the bottom of a door between the jambs.

toenailing
Driving a nail at an angle to join two pieces of wood.

tongue
The shorter and narrower of the two legs of a framing square.

top-flange hangers
Hangers with flanges that attach to the top of supporting members.

transit line
In surveying, any line or a survey traverse that is projected, either with or without measurement, by the use of a transit or similar device.

tread
The horizontal platform of a stair.

trimmer
The structural member on the side of a framed rough opening used to narrow or stiffen the opening. Also, the shortened stud (jack stud) that supports a header in a door or window opening.

truss
An assembly for bridging a broad span, most commonly used in roof construction.

trussed joist
A joist in the form of a truss.

utility knife
A hand-held knife with a razor-like blade, commonly used to cut drywall, sharpen pencils, etc.

valley
The inside angle where two adjacent sections of a roof meet at a diagonal. The opposite of a hip.

valley rafter
A rafter at an inside corner of a roof that runs between and joins with jack rafters that bear on corner walls.

wall puller
A tool used for aligning walls.

wall sheathing
Material, usually plywood, attached to studs to form the outside wall and provide structural strength.

wane
A defect in lumber caused at the mill by sawing too close to the outside edge of a log and leaving an edge either incomplete or covered with bark.

warp
Any variation from straight in a piece of lumber; bow, cup, crook, or twist.

web stiffeners
A piece of wood or composite wood used to provide additional strength for the webs of I-joists.

western framing/platform framing
A framing system in which the vertical members are only a single story high, with each finished floor acting as a platform upon which the succeeding floor is constructed.

worm-drive saw
A circular power saw turned by a worm-gear drive. It is somewhat heavier and produces more torque on the blade than a standard circular saw.

SPANISH FRAMING TERMS

add (v)
agregar

addition
ampliación
expansión

adhesive
pegamento

air compressor
compresor de aire

align (v)
alinear

anchor
anclaje
anclar

anchor blocks
macizos
bloques de anclaje

anchor bolts
pernos de anclaje
tornillos de anclaje

angle
ángulo

angle (v)
angular

architect
arquitecto

area
área

assemble (v)
armar/ensamblar

attic
tapanco
entrepiso

backing
soporte
respaldo

balance (v)
balancear

balcony
balcón
terraza

basement
sótano

beam
viga

beam hanger
colgador/suspensor de viga

bend (v)
doblar

bevel
bisel

blind nailed
con clavos ocultos

block, blocking
trabas
trabar
bloque
bloquear

board
panel
tabla
tablero

bolt
perno
tornillo

box frame
bastidor de cajón

box nail
clavo para madera
clavo de cabeza grande plana

brace
tirante

brace and bit
taladro de mano
berbiquí y barrena

braced frame
estructura arriostrada
pórtico arriostrado

bracing
arriostramiento

bracket
brazo
soporte
ménsula

break (v)
romper

bridging
puntales de refuerzo

brush (v)
cepillar

bucket
cubeta
balde

build/construct (v)
construir
edificar

builder
constructor

building
edificación
edificio

building site
terreno de obra
sitio de construcción
obra de construcción

butt joint
junta a tope

cabinet
gabinete

cable
cable

calculate
calcular

calibrate (v)
calibrar

carpenter
carpintero

carpenter's apron
mandil
delantal

carpenter's square
escuadra

carry (v)
llevar
cargar

casing nail
clavo de cabeza perdida

C-clamp
prensa en C

cedar
cedro

ceiling
cielorraso
techo

ceiling joists
viguetas de techo

chain
cadena

chain saw
sierra de cadena

chalk line
linea de marcar
tendel
linea de gis

chisel
escopio
formón
cincel

circular saw
sierra circular de mano serrucho

circular saw blade
disco

clamp
soporte
grapa

clearance
holgura
tolerancia

climb (v)
subir

close (v)
cerrar

closed
cerrado

closet
clóset
armario

code
código

collar joint
junta de collar

combination square
escuadra de combinación

compact (v)
compactar

compound mitre saw
sierra de corte angular
sierra de ingletes compuesta

compressor
compresor

connect (v)
conectar

connection
conexión
unión

connector
conector

construct (v)
construir

construction manager
gerente de construcción

contractor
constructor
contratista

control (v)
controlar

corner angle
ángulo

corridor
corredor
pasillo

corrosion-resistant
anticorrosivo
resistente a la corrosión

corrosive
corrosivo

count (v)
contar

cover, covering
recubrimiento
tapadera
revestimiento
cubierta

crawl space
espacio angosto
sótano de poca altura

cross connection
conexión cruzada
interconexión

cut (v)
cortar

cut-off saw
sierra para cortar
sierra de madera

cut-out
corte

dead load
carga muerta
carga permanente

deck, decking
cubierta
tablero de lamina

diagonal bracing
arriostramiento diagonal

diameter
diámetro

discontinuous beams
vigas discontinuas

door
puerta

door frame
marco de puerta

door jamb
jamba de puerta

dormer
buharda

doubled
adosado

double plate
solera doble

dovetail
cola de milano

dowel
clavija

drawings (building plans)
planos

drill
taladro

drill (v)
taladrar

drill, electric
taladro eléctrico

drill bit
broca
mecha

driven
impulsado

dry (v)
secar

drywall
muro en seco
tablero de yeso
pirca

dumpster
tambo de basura

earthquake load
carga sísmica

eave
alero

edge (on edge)
canto (de canto a canto)
borde

electrical outlet
enchufe
tomacorriente

enclose
encerrar

enclosed
encerrado

enclosure
cerramiento
cerramiento, recinto

exit
salida

exit stair
escalera de evacuación

expansion bolt
perno de expansión
tornillo de expansión

expansion joint
junta de dilatación/expansión

exposed
descubierto

extension cord
cable de extensión
cuerdas de extensión

exterior/interior surface
superficie exterior/interior

exterior wall
muro/pared exterior

fabricate
fabricar

fascia
imposta

fasteners
anclajes

finishing nail
clavo sin cabeza

fireblock
bloque antifuego

fire extinguisher
extinguidor
extintor
matafuegos

fireplace
chimenea
hogar

fireproof
incombustible

first floor/story
primer piso

flange
brida

flashing
cubrejuntas
tapajuntas
plancha de escurrimiento
vierteaguas
botaguas

flat
plano

flat head
desarmador de hoja plana

floor
piso

floorboard
entarimado

footing
zapata
zarpa
cimiento
zapata de cimentación

force (v)
forzar

forklift
montacargas

forms (concrete)
encofrados

foundation
fundación
cimentación

foundation bolt
anclaje de cimentación

foundation sill plate
placa de solera de fundación

frame
marco
estructura
pórtico
bastidor
armazón

frame, door/window
marco de puerta/ventana

framed
armado

framework
armazón

framing
estructura
intramado

framing square
escuadra

front
frente

furred out, furring
enrasado

gable
hastial

gable construction
construcción a dos aguas

gable rake
cornisa inclinada

gable roof
techo a dos aguas

garage
garaje
cochera

general contractor
contratista general

girder
viga maestra
viga principal
viga
jácena

girder supports/girder posts
apoyos de viga

grade
nivel de terreno
grado

grade beam
viga de fundación

graded lumber
madera elaborada
madera clasificada

grain
veta

groove
ranura

gross area
área total
área bruta

gypsum board
panel de yeso
tablero de yeso
plancha de yeso
plafón de yeso

hacksaw
sierra para cortar metales

hallway
pasillo

hammer
martillo

hammer (v)
martillar

handle
manija
mango
brazo
agarradera

handle (v)
manipular

hand saw
serrucho de mano

hang (v)
colgar

hangers
ganchos
colgaderos

hanging scaffold
andamio colgante

hard hat
casco de seguridad

hardware
herrajes
ferretería

hardwood
madera dura

header
cabezal
dintel
colector

head joint
junta vertical

height
altura

hinge
bisagra

hip
lima
lima hoya
lima tesa

hip roof
techo a cuatro aguas

hold (v)
sujetar/sostener

hold-down anchor
ancla de retención

hole
hoyo
agujero
boquete

hook (v)
enganchar

horizontal bracing system
sistema de arriostramiento
horizontal

hose
manguera

house
casa

impact
impacto

inch
pulgada

incline
declive
inclinación
ladera
pendiente

incline (v)
inclinar
ladear

install (v)
instalar

interior room
cuarto interior

interlocking
enclavamiento

International Building Code
Código Internacional para Instalaciones

jamb
jamba
quicial

job site
lugar de la obra/en la obra
sitio de construcción
sitio del trabajo

join (v)
unir

joint
unión
junta
pegasón

joist
vigueta
viga

joist anchor
anclaje de vigueta

joist, end
vigueta esquinera

joist, floor
vigueta del piso

joist hanger
estribo para vigueta

junction
empalme
unión

king post
poste principal
columna

kitchen
cocina

knife, utility
cuchillo utilitario

ladder
escalera
escalera de mano

laminated wood
madera laminada

landing (stair)
descanso de escaleras

layout
croquis
diseño

lean (v)
apoyar/inclinar

ledge
retallo

level
nivel

lift (v)
leventar
elevar

line and grade
trazar y nivelar

load-bearing joist
viga de carga

lower (v)
bajar

lumber
madera de construcción
madera elaborada

measure (v)
medir

mitre box
caja de corte a ángulos

mitre cut
corte de inglete

mitre saw
sierra de retroceso para ingletes

nail (v)
clavar

nail gun
clavadora automática

nailing, face
con clavos sumidos

nailing strip
listón para clavar

nail puller
sacaclavos

nails
clavos

nail set
botador/embutidor de clavos

nonbearing wall
pared sin carga

nonflammable
no inflamable

nosings
vuelos

nut
tuerca

on center
de centro a centro

open (v)
abrir

opened
abierto

opening
abertura

overhang
voladizo
velo
alero

overlap
traslape
sobresolape
superposición
traslapo

owner
propietario

parallel
paralelo

particleboard
madera aglomerada

partition
tabique
separación
vivisión
partición

partition wall
pared divisoria

perimeter
perímetro

perpendicular
perpendicular

Phillips (head screwdriver)
desarmador de punta de cruz

pick-up truck
camioneta

pitch
pendiente

plan
plano

plane
cepillo

plank
tablón

plumb (v)
plomar

plumb line
hilo de plomada

plywood
madera prensada
tableros de madera prensada
chapeado
triply
madera terciada

pounds per square inch (PSI)
libras por pulgadas cuadradas

power supply
fuente de alimentación

prefabricate (v)
prefabricar

prefabricated
prefabricado

prehung door
puerta premontada

pressure-treated wood
tratada a presión

project
proyecto

property
propiedad
parcela

pull (handle, grip)
agarradera

pull (v)
jalar

push (v)
empujar

quality
calidad

quantity
cantidad

quote (price)
cotización

radial arm saw
serrucho guillotina

radial saw
sierra fija

rafter
cabrio
cabio

rail
cremallera
baranda
barandilla

raise (v)
subir

rake
rastrillo

ramp
rampa

rate of rise
velocidad de incremento

rating
clasificación

reach (v)
alcanzar

recessed
empotrado

reciprocating saw
sierra alternativa

reinforcement
refuerzo
armadura

ridge
cresta
cumbrera

ridge board
tabla de cumbrera

rim
borde

riser
contrahuella

rolling scaffold
andamio movible

roof
techo

roof, flat
azotea

roof, sloped
techo en pendiente

roof framing
armazón de tejado

roofing
techado

roofing square
cadro de cubierta de techo

roof sheathing
entarimado de tejado

roof truss
armadura de cubierta

room
cuarto
sala
habitación

rot
podredumbre

rough-in
instalación en obra negra/gruesa

safety
seguridad industrial

safety glasses
gafas de seguridad

sand (v)
lijar

sander
lijadora

sandpaper
lija

sash
marco de ventana

saw
sierra
serrucho

saw (v)
serruchar

saw, electric
sierra eléctrica

saw, hack
sierra para metales

saw, hand
serrucho de mano

saw, power
sierra eléctrica

sawhorse
burro

sawn timber
maderos aserrados

scaffold
andamio

scale (v)
escalar
desescamar

schedule
horario

scope
alcance

score (v)
marcar

screw
tornillo

screw (v)
atornillar

screw connector
conector con tornillo

screwdriver
destornillador
desarmador

screwed fitting
acoplamiento roscado

shear wall
muro cortante
muro de corte
muro sismorresistente

sheathing
entablado

shim
calza

side-hinged door
puerta con bisagras laterales

sill
soporte

sill plate
solera inferior

site
sitio

skylight
tragaluz
claraboya
lucernario

slope
pendiente
talud
declive
vertiente

soffit
sofito

sole plate
placa de base

span
luz
vano
claro

square
escuadra

squeeze (v)
apretar

stair, landing
rellano

stair, riser
contrahuella

stair, tread
huella

stairs
escaleras

stairway
escalera

stop (v)
parar

story
piso

strapping
flejes

stress
esfuerzo

structure
estructura

stud
montante
parante
barrote

stud anchors
barras de anclaje

stud bearing wall
muro portante con montante

stud walls
muros con montantes
paredes de barrotes

superintendent
superintendente

supervisor
supervisor

support
apoyo
soporte

support (v)
resistir
sostener
soportar
apoyar

table saw
sierra fija
sierra de mesa
sierra circular de mesa

tape measure
cinta de medir

termite
termita

tie
amarra
ligadura
tirante

tie (v)
amarrar

timber
maderos
madera de construcción

toenail
clavo oblicuo

tongue and groove
machihembrado

tool belt
cinturón de herramientas

tool box
caja de herramientas

tools
herramientas

tread
huella
peldaño

truss
cercha
reticulado
armadura
cabreada
caballete

valley (roofing)
limahoya

valley jack
cabio de lima hoya

wall
muro
pared
barda

window
ventana

wood
madera

yard
yarda

INDEX

A
ACQ, 18
advanced framing, 237, 238–239
anchor bolts, 147, 149, 199, 219
anchoring system, 254
anchor nuts, 252, 253
angle cut, 83, 85, 97
APA, 9, 12, 163, 164, 172
attic access, 223
audit, 288
audit checklist, 288

B
backers, 3, 4, 51, 138, 139, 141
  layout, 150–151
backfill, 252, 253
back injuries, 314
bargeboard, 36
beam, 138, 155
beam pocket, 51, 52
bearing walls, 26–27, 44, 138, 164, 164, 214
bird's-mouth, 72, 74, 83, 84, 86
  chart, 103
  finding height of, 97
black locust, 18
black walnut, 18
blocking, 5, 145, 148, 149, 164, 165, 167, 191
  nailing patterns, 32
blocks, 35, 144, 150
boom truck
  hand signals, 322–323
  safety, 321
bottom bearing, 10
bottom plates, 3, 4, 5, 18, 10, 30, 51, 52, 53, 56, 129, 145, 146, 147, 149, 294, 295
  curved, 132–133
  nailing patterns, 24, 27
  setting, 56
braces, 109, 110
  push, 57
  racking, 58
  temporary, 57
  wall, 219–220
building codes, 187–188, 200–234
  evolution of, 206
  framing index, 208
  IBC, 206
  important features, 207
  revisions, 207
  used in this book, 207
butterfly roof, 73

C
calculator, construction, 61, 95, 103–104, 115
casing, exterior, 117, 118
CCA, 18
cedar, 18
ceiling
  framing to code, 222
  heights, 223–224
ceiling joists, 86, 87, 106–107, 223
  nailing patterns, 34
  span chart, 107
chalk line, 53, 56, 60–61, 80, 94, 109, 124, 139, 140, 141, 272
chalking lines duplication method, 74–75, 80
change orders, affect on schedule, 294–304
changes, to plans, 304
channel, 139
cheek cut, 73
circular saws, 315–316
circular stairs, 127–134
communication, importance of, 139, 284–287
computer software, 74–75, 81–82
concrete
  hold-downs, 146, 147

concrete (continued)
  and layout, 143
  nailing patterns, 26
connectors, 193–195
corner, 4, 51, 52, 138
corner, nailing patterns, 25
coupler nuts, 199
crane
  hand signals, 322–323
  safety, 321
crawl space, 10, 43, 279
crew
  performance of, 287
  using effectively, 302
cripple header, 4
cripples, 4, 51, 138, 148, 294
cripple walls, 214

D
decay
  protection of lumber from, 18–19, 176, 292
  prevention of, 228–230
deliveries, 303
delivery schedule, 254
diagonal, 72
diagonal percent, 68
diagonal percent method, 74–75, 82
diaphragms, 186
  construction, 188, 191–193
dimensions
  checking for, 266
  of lumber, 6
  standard, 257–258
doors, 113–118
  sliding glass, 121
door stop, 116
double backer, 138
double joist, 155, 210
double plate, 4, 5, 34, 35, 52, 56, 57, 86, 87, 133, 138, 146, 149
  nailing patterns, 25, 32
  setting, 56
double plates, 215
double stud, 138
drawings, roof and floor, 153
drywall, 117
  backing, 45
  cart, 291
  nailing patterns, 33
Dutch hip roof, 73

E
ear protection, 314
earthquake, framing considerations, 184–200
  building code, 187–188
  structural loads, 186
engineered panel products, 7–8, 162
engineered wood, 7–12, 159–181
extra work, 305
eye protection, 314

F
fall protection, 317–318
fascia, 36, 77, 93, 111
  covering, 94
fireblocking, 215, 218
fire protection, 32
flashing, 55, 119, 120, 121
flat roof, 73
floor, squeaks in, 8
floor joist, 5
  framing, 210–213
  and IBC, 210
floors, 39–46
floor sheathing, 297
footprint sketch
  dimensions, 271
  elevations, 273
foot protection, 314
Forest Stewardship Council (FSC), 240
forklift
  center of gravity, 319–320
  hand signals, 320
  safety, 319–321
foundation
  cripple walls, 214
  stud heights, 272, 274
fractions, 301
framing, terms, 3-5
framing, tips, 294–301
framing square rafter method, 74–75, 78
framing square stepping method, 74–75, 79

G
gable ends, 110
  setting, 109
  sheathing, 109
gable roof, 73
gambrel roof, 73
girders
  built-up, nailing patterns, 32
  protection, 229
glu-lam beams, 8, 9, 161, 172–177, 292
goals, 283
grade stamps, 12
grain, 163
green framing, 235–247
green framing feeling, 238
guardrails, 318
gun hangers, 315
gypsum wallboard, 7, 33

H
hand tools, 315–316
hard hats, 314
hardware, 252, 253
header jam, 116
headers, 51, 52, 116, 124, 138, 215, 294
    nailing patterns, 28
    sizes, 215
    spreading, 50
hinge, 117
hinge jamb, 116, 117, 118
hip and valley rafters, 92, 101, 102
    adjustment, 89, 97
    cutting, 89–90
    finding length of, 88
    run, 72, 88
    setting, 91
hip roof, 73
hip run, 72, 100
hold-downs, 144–147, 148, 149, 195–200, 252, 254
    installing, 299
housekeeping, job site, 321

I
IGCC (International Green Construction Code), 237
I-joists, 8, 9–11, 161, 163–171
    hardware, 11, 164, 167–169
    sizes, 171
International Building Code (IBC), 23, 190, 206
International Residential Code (IRC), 23, 206

J
jack rafters, 73, 104
    adjustments for, 96, 101
    setting, 92
jack studs, 3, 4
job, preparing for a, 249–262
job site, organizing, 259
job start checklist, 251, 252–254
joists, 19, 43, 124, 133, 279
    blocking, 44
    crowning and placing, 40–42
    floor, 126, 145, 149
    layout, 154–155
    nailing patterns, 32
    protection, 229
    tips, 296

K
king common rafter, 101
king stud, 4, 133

L
ladders, 317
laminated lumber, 8, 9, 161
lapping joists, nailing patterns, 33
laser, 59, 266
latch jamb, 116, 117
    nailing, 118
layout, 136–157
    joist, 154–155
    language, 138
    roof, 156–157
    tools, 154
    wall, 139–154
lead framer, 277–287
learning curve, 308
ledger, 124
LEED (Leadership in Energy and Environmental Design), 237
let-in bracing, nailing patterns, 29
level, 58, 59
    checking building for, 265, 270–272
L-header, 4
lifting, proper, 315
load path, 186
location marks, 152
lockset, 118
lookouts, 93, 111
lumber
    cutting, 17
    dimensions, 6
    drop location, 252, 253
    grade stamps, 12
    protecting, 18–19, 292
    stacking, 309

M
management
    of framing start, 263–274
    of framing team, 276–309
    types of, 281
material, organizing, 291–292, 301
material list, 252, 253
material movement, 308–309
    for joists, 296
    for walls, 294
Material Selection, 239–241
materials, planning for, 303
metal plate-connected wood trusses, 161, 178
mitre saw, 301
motion analysis, 308
motivation, 280, 282
movement, of materials, 308–309
mudsill insulation, 252, 253
multiple cutting, 308
multiple-framer tasks, 308

N
nail-flange windows, installing, 55, 115, 119–120
nail gun, 315

nailing
    to code, 230–233
    of hinge jamb, 117
    joists, 296
    patterns, 21–36
    rafters, 297
    sheathing, 298
    of wall, 56, 294
nail regulator, 192
nails, 14, 23
nonbearing wall, 4, 138, 214
    nailing patterns, 26–27
nosing, 126

O
occupancy classification, 208
openings, framing, 43, 54, 55
oriented strand board (OSB), 162, 240
OSHA, 314, 315, 317

P
pallet jack, 291
panel pilot router bit, 54
panel products, engineered, 7
parallel strand lumber, 8, 9, 161
particleboard, 8, 162
partition, 3, 139
personal fall arrest systems, 318
personalities, dealing with, 286
personal protective equipment, 314
pick-up lists, 289
pitch, 72, 78, 79, 82, 94, 101
planning and scheduling, 302–305
plans
    changes to, 304
    checking, 116, 117
    copies of, 252, 253
    organizing, 259
    reviewing, 255–258
    solving problems with, 285
    taping, 256
plan shack, 262
plumb and line, 57–58
    tools for, 59, 87
plywood, 8, 161, 162
    nailing off, 293
pneumatic nailers, 52, 192
power-actuated tools, 316
power source, 252
pre-hung doors, 115–116
preparation, for job, 249–262
productivity, 287, 306–309
protection, of materials, 292
push-brace, 57
Pythagorean theorem, 74–75, 76–77

Q
quality control, 288–289

R
racking brace, 58
radius, 130
rafter, nailing patterns, 34–35
rafters, 72–105
    block, 93
    common, 72, 73, 74, 87
    cutting, 74, 83–85, 95
    drilling and notching, 221
    finding lengths of, 74–82, 95–105
    framing to code, 220
    guidelines, 95–105
    hip, 73
    jack, 73
    layout, 156–157
    nailing patterns, 34
    ridge end, 73
    setting, 87
    tail length, 78
    terms, 72–74
    tips, 297
    valley, 73
rake walls, 60–68
    building, 64
    chalking lines for, 60–61, 64
    figuring lengths of, 61–64
    hip, 72
    hip jack, 72
    valley, 72
ramps, framing to code, 225–227
recordkeeping, 304–305
redwood, 18
reference lines, 265, 267–270
reveal, setting, 56
ridge, nailing patterns, 34
ridge board, 34, 72, 86, 87, 92, 93, 101, 102, 220
    finding lengths of, 105
    installing, 297
ridge support, 86
rim board, 11
rim joist, 5
    nailing, 29, 41
rise, 72, 76, 77, 78, 79, 82
riser, stair, 122, 123, 124, 126, 127, 133
roof, 279
    failure, 200
    framing, 69–112
    layout, 87, 156–157
    sheathing, 5, 298
    styles, 73
    truss, 5, 34, 107
run, 72, 76, 77, 78, 79, 82

S

safety, 311–324
saws, circular, 315–316
schedule, 262, 302
seismic design categories, 208, 211
seismic map, 190
shear walls, 148, 186, 288
    construction, 188–191
    wall schedule, 194
sheathing, 5, 7, 45–46, 54, 86, 87, 93, 111, 124, 142, 146, 295, 297
    installing, 94, 163
    nailing patterns, 31
    tips, 297–300
shed roof, 73
shims, 116, 118
siding, 150
sill, 4, 51, 294
sliding glass door, installation, 121
slow-downs, avoiding, 303
snow loads, 189
sole plates, 3, 4, 5
span, of rafters, 72
speed square, 83, 85
speed versus quality, 308
spiral stairs, 226, 227
square, 83, 85, 125
    checking for, 265
    walls, 53, 295
squash blocks, 11, 166
stairs, 115
    circular, 127–134, 226, 227
    framing to code, 225–227
    handrails, 226
    headroom, 122, 123, 124, 225–226
    installation of, 122–134
    measuring height of, 122
    nosing, 126
    riser, 122, 123, 124, 126, 127
    spiral, 226, 227
    stringers, 122, 124, 125
    tread, 122, 123, 124, 128, 129–130, 133, 134
stamps, grade, 12
start, of project, 263–274
stock, correct, 303
storage, of materials, 291
stringers, 122, 124, 125
structural compsite lumber (SCL), 178
Structural Insulated Panels (SIPs), 241–247
    SIP Tools, 247
structural loads, 186
struts, 108
studs, 4, 5, 19, 51, 52, 56, 86, 87, 117, 138, 141, 146, 294
    calculating heights, 62, 64, 272
    double, 138
    layout, 150
    nailing patterns, 24–25
    staggered, 138
    trimmer, 138
stud trimmer, 52
subfascia, 93
subfloor, glue, 252, 253
subfloor sheathing, 5, 45–46, 149
supplier, materials, 137
Sustainable Forestry Initiative (SFI), 240

T

tail joist, 155
tape measure, 301
tasks
    assigning, 293
    multiple-framer, 308
teaching framers, 292–293
team, framing, 276–309
    managing, 278
temporary braces, removing, 300
termite protection, 234
threshold, 116, 117, 121
tie-downs, 254
timekeeping, 304
tips, framing, 294–301
tips, safety, 324
toilet clearance, 151
tongue and groove panels, 7
tools, 14–15, 259–261
    maintenance schedule, 309
    organizing, 289–290, 321
top plate, 4, 5, 34, 35, 51, 56, 57, 87, 125, 133, 146, 151, 294
    nailing patterns, 24–25
transition coupler, 149
transit line, 272
tread, stair, 122, 123, 124, 128, 129
    circumference for, 131
    cutting, 130
    footprint, 132
    nailing, 130
    walls, 129–130, 133, 134
triangle, 3–5, 61–62, 76, 268
trimmer joist, 155
trimmers, 3, 4, 26, 117, 118, 133, 141, 151, 294
    nailing patterns, 26
TRise, 77
truck
    location of, 254
    organization of, 3, 16, 291
TRun, 77
trusses
    blocking, 111

trusses (continued)
flying, 180–181
framing to code, 222
lateral bracing for, 180
nailing patterns, 34
pitched, 179
pre-fabricated, 71
roof, 107
spreading, 108

U
USGBC (United States Green Building Council), 237

V
valley rafters, 72
cutting, 89
finding length of, 88
layout, 156–157
metal plate-connected, 178
rolling, 110
run, 72, 88
setting, 90
vapor retarder, 18
ventilation, 228
Volatile Organic Compounds (VOCs), 240

W
waferboard, 8, 162
wages, 306
walls, 47–68, 279
assembling, 52
bearing, 4, 138
bracing, 219–220
building, 294–295
dimensions, 265, 266–267
framing to code, 214–218
layout, 139–154
nailing, 56
nonbearing, 4, 138
plates, 143, 151
plumbing, 54, 57–58
racking, 58
rake, 60–68
setting, 56
sheathing, 54, 298
squaring, 53
standing, 56
waste, taking into account, 303
web stiffener, 10, 166
Western Wood Product Association, 12
wind
building code, 187–188
framing considerations, 184–200
speed, 189
structural loads, 186
windows, installing, 55, 115, 119–120
wood, decay-resistant, 18
work, extra, 305